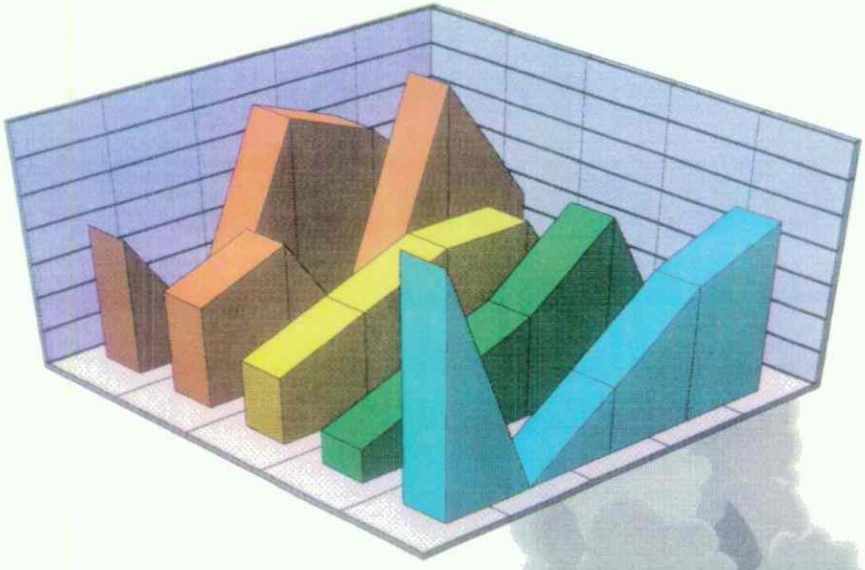
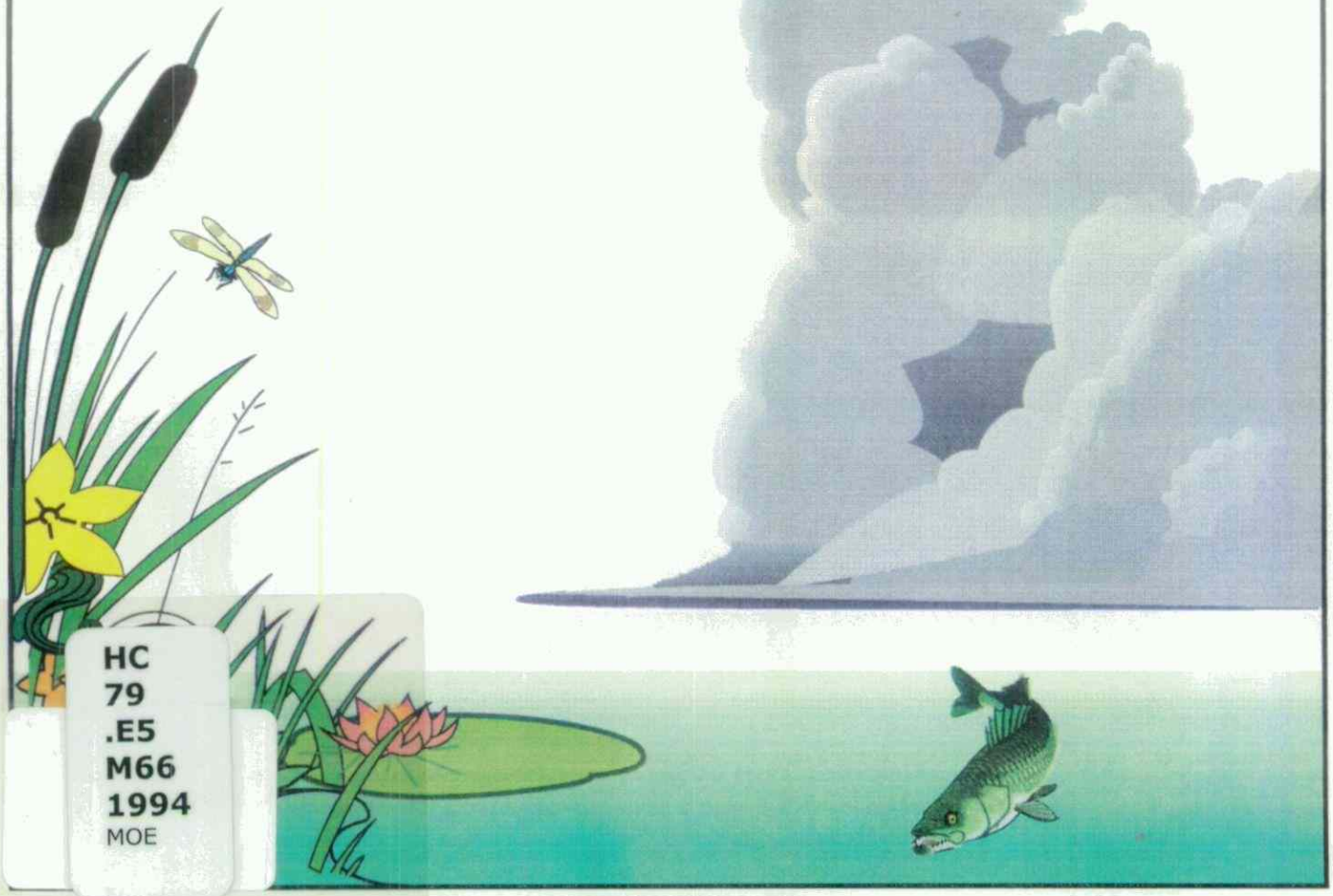
Monitoring Review

Ontario
Ministry of Environment
and Energy





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SUMMARY REPORT

RECOMMENDATIONS AND FEEDBACK
November, 1994

Summary Report
Recommendations for Future MOEE Monitoring and Reporting Efforts

1. OVERVIEW OF THE MONITORING REVIEW

In November of 1993, the Environmental Sciences and Standards Division (ESSD) underwent an extensive re-organization to better enable it to meet the multi-media challenges in the development and delivery of its many environmental initiatives. As part of this re-organization, the Environmental Monitoring and Reporting Branch (EMRB) was formed, with the mandate to take a lead role within ESSD for the coordination and integration of monitoring and environmental reporting efforts. This report is an important step in that process.

To that end, EMRB initiated an extensive review of existing monitoring programs, in order to make recommendations on better integration of monitoring efforts, to identify priorities for future monitoring and reporting, and to identify cost and resource impacts of these recommendations.

Initially, a series of meetings were held by senior EMRB staff to develop a strategy for this initiative, which was then presented and accepted by Divisional Directors and the ADM. The strategy included:

- A generic set of goals and objectives for monitoring and reporting which provided a focus for the review (see appendix 1).
- Initiation of five working groups to review existing monitoring programs and present recommendations for future monitoring directions, based on the goals and objectives of monitoring and reporting. The working groups focused on air, surface water, groundwater, drinking water, and biomonitoring (see appendix 2 for listing of working group members).
- A set of working group terms of reference to ensure members were consistent in their approaches and procedures (see appendix 3 for working group terms of reference). These terms of reference were altered slightly by individual working groups, but the general emphasis remained the same.
- Initiation of a working groups coordinating committee composed of working group leaders and a facilitator.

This strategy has formed the basis of the monitoring reviews and the resulting recommendations in this report. The options and recommendations are the product of extensive consultation and discussion by working group members, both individually and through inter-working group workshops. A significant amount of support documentation has been developed by the working groups and has provided valuable information for the development of options and recommendations. Summaries of this documentation are provided and include:

- The questionnaire which was used to summarize existing monitoring programs (see appendix 4).
- A summary of questionnaire information on existing MOEE monitoring programs (see appendix 5).
- A comprehensive inventory of over 200 existing provincial, federal and NGO monitoring data bases (see appendix 6).

2. RATIONALE FOR MONITORING

It is important at this point, to provide a definition of monitoring to ensure a consistent understanding of its meaning. Drawing from a recent definition provided by Environment Canada to the Canadian Council of Ministers of the Environment (CCME), monitoring is defined as:

The interactive, interdisciplinary design and use of methods to measure, observe, archive, analyze, track, predict and report on environmental pollutants and on parameters that reflect the state of air, water, land and biota. This will provide information and knowledge for decision-making about the environment and human safety.

It is also very important to recognize the critical linkage between monitoring and MOEE's current environmental management mandate. The MOEE's environmental mandate is stated as follows:

Mandate of MOEE

To protect the quality of the natural environment so as to safeguard the ecosystem and human health: coordinate the government's energy supply and demand-related activities; and foster the efficient use and conservation of resources.

In addition, within the guiding principles of the Environmental Bill of Rights, the MOEE has clearly stated that **"the Ministry will adopt an ecosystem approach to environmental protection and resource management"**, and further states that the Ministry will consider interdependence of air, land, water, and living organisms when making decisions.

Without monitoring, the mandate and guiding principles are unachievable. Monitoring, as defined above, has a number of crucial applications to the mandate and guiding principals including:

- Provides ongoing assessment of environmental status
- Provides early warning of emerging environmental threats
- Provides a scientific basis for establishing program/policy priorities
- Measures impact of human activities on the environment
- Serves to protect public health and safety
- Highlights cause and effect relationships
- Provides measures of success of remedial actions

Monitoring is a fundamental function to fulfilling MOEE program activities and it includes:

- Regulation development
- Environmental reporting
- Informed environmental decision-making
- Enforcement and compliance
- Support for economic activities
- Assessing the effectiveness of public policy
- Research and technology development
- Emergency support
- Public education and training
- Support for standards development
- Formulating public policy

3. PRIORITY ENVIRONMENTAL ISSUES

As part of the working group reviews, a list of key environmental issues and their links to monitoring was developed to provide an issue focus to the monitoring reviews. It also identified the need for an ecosystem approach in resolving environmental issues of concern. In addition, a copy was also provided to the Science and Technology Branch for their use in the ESSD priority-setting initiative. This initiative could have a significant impact on future monitoring efforts, and close liaison between the two groups is being maintained. As part of this Priority-Setting initiative, the list currently identifies 18 issues. These issues and their existing or potential application to the types of medium are presented in the attached table:

APPLICABILITY OF MONITORING PROGRAMS TO ENVIRONMENTAL ISSUES

ISSUE	Surface Water	Ground Water	Drinking Water	AIR	BIOTA
Acidification	X	X	X	X	X
Aesthetics (air & water)	X	X	X	X	X
Air Particulates				X	X
Biological Contamination	X	X	X	X	X
Drinking Water Quality		X	X		
Eutrophication	X	X	X		X
Ground-Level Ozone	X			X	X
Groundwater Deterioration	X	X	X		
Global Warming		X		X	X
Habitat Deterioration	X	X			X
Hydrologic Change	X	X	X		X
Land Use Change	X	X			X
Non-Native Species Impacts	X				X
Physical Stress	X			X	X
Resource Depletion	X	X	X	X	X
Solid Waste Disposal	X	X		X	
Toxic Contamination	X	X	X	X	X
Impacts from Stratospheric Ozone Depletion	X			X	X

4. ANALYSES, EVALUATION AND RECOMMENDATIONS FOR MONITORING

4.10 ECOSYSTEM APPROACH

4.11 Purpose of the Ecosystem Approach

In order to address the concept of an ecosystem approach effectively, it is first necessary to define what "ecosystem" means.
An ecosystem is described as an integrated and stable "association" of living and nonliving resources, functioning within a defined physical location (Burnett et al 1989).

The concept of an ecosystem approach is a departure from the traditional view of emphasizing individual elements or components of the environment. Instead, this approach moves towards a more comprehensive ecological focus that addresses the interrelationships and interactions of various natural, social and economic system components. This concept is very important in that healthy ecosystems, to a large extent, have the ability to maintain their organization and function through resilience (the ability to cope with stress), productivity, vigour, balance and harmony. To that end, as mentioned earlier in the report, the Ministry has made a clear commitment to work towards this approach, in its ministry mandate, in its statement of environmental values, and also within the monitoring working group goals and objectives.

In the goals and objectives of monitoring (see attachment 1), we state that our goal for monitoring is:
To assess and report on the state of Ontario's environment in support of informed decision-making that leads towards the restoration and maintenance of the province's ecosystems.

This entails moving beyond the measure of pollutants and focusing on the contributions of all mediums with respect to their overall contributions to ecosystem health and integrity. Specifically the implications of an ecosystem approach to monitoring are:

- An effective ecosystem approach demands a leadership role from MOEE to establish ecosystem management goals and objectives, which in turn provides a focus for provincial monitoring efforts. This would be a significant time and resource commitment and would involve discussions with the many groups, government, non-government and the public at large.
- Monitoring efforts are conducted to measure environmental status with respect to ecosystem management goals and objectives.
- Consistency of measurement within and between ecosystems is achieved by using a series of environmental indicators of ecosystem health and integrity.
- Medium-specific monitoring still occurs, but is done as a component of a larger ecosystem monitoring framework that, by nature, integrates the individual monitoring efforts.
- The adoption of a more holistic, ecosystem approach to dealing with environmental issues will also enhance the capability to easily and effectively bring together, integrate, synthesize and analyze data and information from many different MOEE and outside sources.

Clients for ecosystem-based information include the following:

- Government/NGO organizations, Ontario public, public interest groups and the media.
- MOEE and other government policy-makers and decision-makers.
- Municipalities, industries and consultants
- Academia

4.12 Description of Current Monitoring Efforts

Prior to the re-organization of ESSD in November, 1993, each Branch was responsible for all monitoring related to their medium of responsibility, which made it difficult to adopt an ecosystem approach to monitoring. The ESSD reorganization integrated the coordination of all medium-specific monitoring programs This allows the development of more integrated approaches, so that all aspects of the environmental status of a particular area of interest can be investigated, and an integrated evaluation of the current status and past/future trends in the environmental health of the area of interest can be made.

There are presently a wide variety of monitoring programs being conducted by various jurisdictions in Ontario, including the MOEE, Environment Canada, Ministry of Natural Resources (MNR), Conservation Authorities, The Ontario Ministry of Agriculture Food and Rural Affairs (OMAFRA), Ontario Hydro, Non Government Organizations (NGOs), Canadian Wildlife Service, The Department of Fisheries and Oceans (DFO), and others. Generally, these programs are geared to meeting individual jurisdictional needs and are not linked to any provincial framework. There are however, excellent examples of joint efforts in monitoring. For example, the MOEE has established inter-governmental partnerships for the sportfish contaminant, streamflow monitoring and air monitoring programs, and for the Remedial Action Plans (RAPs).

Certainly, current monitoring programs generate some information which is useful in assessing ecosystem health; however, over the past decade, there was a general move to collecting data which tends to be localized and of a short-term nature. This is primarily due to increasing resource constraints and MOEE client demands for this information in support of regulations, agreements and problem investigations.

A key element of ecosystem monitoring is the use of environmental indicators for assessing the health within and between ecosystems. To date, MOEE efforts to develop a framework for the use of ecosystem indicators have been minimal. Environment Canada is currently attempting to develop a menu of indicators which could be applicable to all provinces, but these are still at a preliminary stage.

Management and integration of environmental data continues to be an isssue of concern within MOEE. Currently, a large percentage of MOEE environmental quality data is temporarily stored in the Laboratory Information Management System (LIMS), and once approved, the results are transferred by tape to the corporate Sample Information System (SIS), on the IBM mainframe. Data is then downloaded to various types of data bases within the individual sections for additional quality assurance and quality control procedures. The SIS is an antiquated system, written in outdated, business-oriented COBOL language. The system is inflexible, and very difficult, expensive and time-consuming to modify to meet new needs. The data is stored non-relationally, making it extremely difficult to access, edit, validate, integrate, analyze and interpret. In most cases, practical operation requires that data corrections and analysis are done to the data at the individual data base level and not to the data stored on SIS. Since SIS is recognized as the corporate data base, staff must deal with this cumbersome system.

Many jurisdictions have now adopted relational database technology. In relational data base technology, data base tables represent discrete or uniform "things" about which we collect data. These tables are then related or linked on the basis of common keys. For example, a table describing samples can be linked to a table describing results because both carry a common sample code key. Because of this, it is possible to search a particular data base, or even link several data bases, using a standard query and search approach called Structured Query Language (SQL). SQL can retrieve **all** data with a particular relationship to some key item. So, for example, with a single query, you would be able to search the

Hazardous Waste Information System (HWIS) data, the Municipal and Industrial Strategy for Abatement (MISA) data, and the Air Emissions data bases for all the data on waste, aqueous and air emissions from a particular company, assuming all of these data bases carried a unique company identifier as the common search criteria.

The reporting of environmental information has focused predominately on medium-specific scientific reports, with primary clients being Branches and Divisions within the MOEE, and the scientific community in general. Minimal emphasis has been put on reporting environmental status information (particularly information that may be used to describe ecosystem heath and integrity) to technical and non-technical client groups.

4.13 Costs of Monitoring

The table below does not specifically summarize ecosystem monitoring costs but is meant to provide a summary of current MOEE medium-specific costs and roll-ups:

(All amounts in $000s)

Medium	EMRB		OD		LSB		Other MOEE		Overall Totals	
	ODOE	PYs	ODOE	PYs	ODOE	PYs	ODOE	PYs	ODOE	PYs
Air	721	22	780	35	73	13	130	3	1704	73
Surface Water	684	16.5	157.5	8.2	711	31	690	18.5	2242.5	74.2
Ground-water	100	5	20	16	-	-	-	-	120	21
Dr.Water	175	4	95	7	600	30	50	2	920	43
Biomon.	310	10	-	0.5	180	22	290	15.5	780	48
Totals	1990	57.5	1052.5	66.7	1564	96	1160	39	5766.5	259.2

4.14 Gaps and Needs

General

- Limited "ecosystem approach" focus of current monitoring and reporting efforts in Ontario.
- Presently no coordination of provincial monitoring efforts which facilitates greater efficiencies, harmonization and holistic approaches to monitoring and reporting.
- Lack of emphasis on using environmental indicators to provide a sense of consistency and comparability between monitoring efforts.

Data Management

- Need for development of an integrated data management system that is modern, relational, flexible and economical to modify, provides easy access to all staff through the Ministry network, and facilitates the ability to edit, validate, integrate, analyze and interpret environmental data.

Environmental Reporting

- Provision of integrated environmental reports for technical and non-technical clients that provide them with the state of Ontario's environment at various levels.
- Provision of issue-oriented environmental status reports that provide status of environmental issues (eg. toxic contamination) and the impact from integrated pathways.

4.15 Recommendations

- MOEE should take a leadership role in promoting an ecosystem approach to environmental management through the following actions:
  - By initiating an ecosystem-based approach to monitoring within a specified site in Ontario. Potential sites could be the nearshore area of Lake Ontario (or other Great Lakes), the Grand River, or in conjunction with Environment Canada's Ecological monitoring sites in Ontario, or other. This approach will include the setting of ecosystem goals, development and use of environmental indicators of ecosystem health and integrity, ecosystem monitoring of indicators and reporting of ecosystem status. Based on the success of this approach, the ecosystem approach could be expanded.
  - by initiating discussions with provincial partners to develop a series of indicators of ecosystem health as an important tool for ecosystem monitoring.
  - ESSD will promote the ecosystem approach to environmental monitoring by ensuring yearly planning for monitoring programs includes discussions and decisions that incorporate a more holistic approach to monitoring.
  - ESSD will work towards an ecosystem approach by identifying current multi-jurisdictional monitoring partners in Ontario (see attachment 6 for listing of these efforts) and, will work with these partners, to promote greater coordination and integration.
  - **Resource implications** - Resource neutral, based on slight alterations of existing programs.

- ESSD should participate in the "Datashare" project spearheaded by Fiscal Planning and Information Management Branch (FPIM), which will develop a new relational approach to environmental data management, based on client/server technology, and using the ministry's Local and Wide Area networks to provide universal access for ministry staff to all MOEE databases. This modern approach will provide a more flexible, cost-effective and user-friendly data environment for MOEE staff, as compared to SIS, which has been a continuous source of frustration for MOEE staff working with environmental data.
  - **Resource implications** - Significant, depending on level of participation

- EMRB should take a lead role in the development of reports that assess provincial environmental status at various levels. These reports will provide information to MOEE policy-makers and decision makers and will also provide general information to the public on the state of Ontario's environment. Specific types of reports include:
  - Medium-specific environmental status reports.
  - A provincial state of the environment report, which integrates government/NGO monitoring efforts to assess provincial environmental status.
  - A series of fact sheets/brochures based on environmental issues, which address an important educational need for client information, and provide support for environmental priorities. Examples of fact sheets/brochures would be a provincial focus for:
    - Ground level ozone
    - Habitat deterioration
    - Eutrophication of the Great Lakes
  - **Resource implications** - Resources currently in place to carry this out.

4.16 Feedback on Ecosystem Approach Recommendations (Please check appropriate response)

Ecosystem Approach (General)

1a. Do you subscribe to the ecosystem approach? Yes__ No__

1b. If no, please comment._____

_____

_____

_____

1c. If yes, should the MOEE take a coordination role in this effort? Yes__ No__

1d. If yes, who within the MOEE should be the coordinator (Name Branch)? _____

1e. Should the MOEE coordinate provincial monitoring efforts? Yes__ No__

1f. If yes, who within the MOEE should be the coordinator (Name Branch)? _____

1g. Should we initiate an ecosystem-based monitoring program within a designated site in Ontario to promote this approach? Yes__ No__

Additional comments _____

_____

_____

_____

Use of Indicators

2a. Is it important to develop and utilize indicators of ecosystem health? Yes__ No__

2b. If yes, should MOEE take a lead role in this initiative? Yes__ No__

2c. If yes, who in MOEE should take the lead role in this initiative? (Name Branch)? _____

Additional comments _____

_____

_____

_____

_____

_____

Data Management

3a. Would you support an ongoing initiative to replace the current SIS system with a network (LAN\WAN) based client\server system, using relational data management technology (ORACLE?) for storing environmental quality monitoring data. Yes__ No__

3b. If yes, who should lead this effort? _____

3c. Would you be willing to provide ODOE to support the renovation and migration of data to this system? Yes__ No__

3d. Would you be willing to provide staff time to support the renovation and migration of data to this system? Yes__ No__

Additional comments _____

Environmental Reporting

4. Do you feel the following reports should be MOEE priorities?

Medium-specific environmental status reports?	Yes__ No__
Multi-media state of the environment reports?	Yes__ No__
Issue oriented fact sheets and brochures?	Yes__ No__
Other types (Please name)	

_____
_____
_____
_____

Additional comments _____

5. Please provide any other comments here.

4.20 AIR MONITORING

4.21 Purpose of Monitoring

The main purpose of air monitoring is to assess and report on the state of Ontario's air quality. With slight modifications it is ideally suited to provide input to ecosystem monitoring anywhere in the province. In addition, air monitoring in Ontario is carried out for the following reasons:

- To inform the public on a real-time basis so they can respond appropriately to pollutant levels;
- To provide an episode warning and control mechanism for the protection of human health;
- To assess the quality of air in Ontario and evaluate trends; identify both areas of non-attainment and the origin of pollutants;
- To assess the effectiveness of pollution abatement activities;
- To provide data for compliance and complaints investigations;
- To trigger immediate compliance;
- To provide the basis for the development of air management strategies;
- To provide quantitative measurements for abatement action;
- To demonstrate the extent that U.S. sources cause problems in Ontario;
- To enable the setting of meaningful air quality criteria;
- To provide information on the interaction between various media;
- To assist in the assessment of ecosystem damage caused by air pollution; support research activities on ecosystem assessment and management;
- To support other networks.

The clients for the air monitoring information include:

- The general public, the press and other media, non- governmental organizations (i.e., public interest groups);
- Researchers on human health, agriculture and ecosystem;
- The various divisions of our Ministry including, Operations Division (the various regions, Approvals Branch, Investigations and Enforcement Branch, Spills Action Centre, Policy Division (Economic Services Branch, Policy Development Branch, Intergovernmental Relations Office), Environmental Sciences and Standards Division (Program Development Branch, Science and Technology Branch, Standards Development Branch);

- Municipalities, Industries and Consultants;
- Other Ontario Ministries including the Solicitor-General, Labour, Health, Natural Resources and Transportation;
- Agencies of the federal and provincial governments of Canada, (i.e., Environment Canada, Health Canada), Environment Quebec, U.S. Environmental Protection Agency and various state agencies, United Nation agencies, schools and universities.

4.22 Description of Current Monitoring Efforts

The air monitoring program of the MOEE has been in place since the 1960's. Since 1971 the data have been published annually.

Ambient and source specific air monitoring is conducted at fixed monitoring sites across the province. Concentrations of traditional air contaminants (sulphur dioxide, nitrogen oxides, carbon monoxide, ozone, suspended particulates and total reduced sulphur) are obtained from 86 ambient monitoring sites. In addition there are 95 sites providing source specific total suspended particulate data, 173 dustfall sites, 74 fluoride sites, and 24 sites measuring inhalable particulate (PM_{10}). Volatile organic compounds are monitored at 16 sites, polyaromatic hydrocarbons at 11 sites and dioxins at 2 sites. Also a network of deposition samplers is used to collect data for acidifying contaminants and toxic pollutants.

In addition to the fixed site sampling, mobile monitoring is carried out for emergency response and for surveys near specific sources of pollutants, and specialized monitoring studies are conducted by regional staff.

There are several data bases that are associated with the air program i.e., Air Quality Information System (AQUIS), the Meteorological Data Acquisition System (MDAS), the Ontario Emission Inventory System (OEIS) as well as separate data bases for volatile organic compounds (VOCs, polynuclear aromatic hydrocarbons (PAHs), acids and toxic deposition.

The data (approximately 4 million air quality points added per year) are analyzed for spatial and temporal trends for the province as a whole and at various subregions of the province. This is done by integrating meteorological, emissions and air quality data. Source-receptor analyses and compliance/complaints investigation are also used in assessment.

Public information is provided (per regulations) through the Air Pollution Index (API), the Lambton Industry Meteorological Alert (LIMA), the Air Quality Index (AQI), the Air Quality Advisory and the annual Air Quality Report. The API, LIMA, AQI and air quality advisory programs use real-time air quality information. Both the API and LIMA are compliance oriented.

4.23 Costs of Operation

The Air Monitoring Program is managed jointly by the Environmental Monitoring and Reporting Branch (EMRB), Science and Technology Branch (STB) and the Regional Offices of the Operations Division, along with input from the National Air Pollution Surveillance (NAPS) of Environment Canada, through the Air Quality Management Committee (AQMC). The following table summarizes the operating costs of the air monitoring program during fiscal year 93/94.

Division/Branch	ODOE (K)	PY
ESSD/EMRB/AQM	532 *	17
ESSD/EMRB/TAGA	189	5
Regional Operations	780	35
ESSD/LSB	73	13
Other MOEE	130	3
TOTAL	1,704	73

* FY1989/90 AQM ODOE was 760 K.

The AQMC reviews the air monitoring program on a continual basis for efficiency and effectiveness.

4.24 Gaps, Needs and Options

This review has examined the air monitoring program in terms of past, present and future needs, with a view towards multi-media integration and reporting, and ecosystem monitoring. Based on this review the committee has identified the following gaps/needs:

- EMRB should coordinate with Environment Canada and Operations Division the installation of ozone and low-level nitrogen oxide monitors along the shorelines of the Great Lakes;
- AQMC should accurately identify the impact of sources by integrating source data and ambient monitoring data;
- EMRB should develop a continuous PM_{10} monitoring program, working in partnership with Environment Canada and Operations Division;
- ESSD should develop data quality objectives and the need for PAH speciation in risk assessments;
- EMRB should develop methods of defining VOC levels and trends to ascertain progress in NO_x/VOC initiatives. Remote sensing monitors for VOC species could be developed working in partnership with Environment Canada, other Branches and Operations Division;
- ESSD should develop a monitoring program to capture VOC species for input into assessment of ground level ozone;
- EMRB should ensure the transfer of all ambient monitoring data into a centralized data base;
- ESSD should develop, clear and enforcible regulations and monitoring methods to deal with public nuisance pollution (i.e., black fallout, odours, chemicals);
- ESSD should develop sampling and analytical methods for additional compounds, especially the capability to identify odorous compounds and determine if there are more serious impacts for these compounds than odours;

- ESSD should develop air quality objectives and standards for additional pollutants and provide more timely reviews of current standards;

- ESSD should develop a non risk assessment approach for non-threshold effect pollutants.

In order to best fill in the gaps and satisfy the needs listed above, the following options are identified:

Option A Continue to monitor for air contaminants with network optimization * and emphasizing the addition of PM_{10}, ozone along the shorelines of the lower Great Lakes and low-level NO_x monitoring in rural areas.

Option B Continue to monitor for air contaminants as in option A, including the use of remote sensing monitors. This option will require some additional resource. Explore partnership and RAC fundings.

Option C Continue to monitor for air contaminants including remote sensing as in option B, and develop additional enforceable regulations and monitoring methods for problem areas in Ontario, as required.

4.25 Recommendations

1. Implement Option A immediately since through network optimization * it is resource neutral + and it will improve monitoring efficiency in the areas of shoreline NO_x and ozone and for continuous monitoring of PM_{10}.

   The following can also be undertaken under option A:
   - Limited examination of canister based monitoring techniques for VOC;
   - Limited studies on reconciliation of air emissions and ambient data;
   - Development of data quality objectives for organic monitoring;
   - Ensure the transfer of all ambient data from the monitoring network into a centralized data base.

2. Implement Option B in partnership and coordination with other agencies as resources are made available.

3. Implement Option C in consultation and partnership with Program Development Branch, Standards Development Branch, Science Technology Branch, Operations Division and Federal Agencies.

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* **The air monitoring network optimization is done continuously by the Air Quality Management Committee. For example, the network was downsized by approximately 20% in 1991 after a review.**

\+ **For further information see detailed Gaps/Needs table in main air monitoring program review document.**

4.26 Feedback on Air Recommendations (Please check appropriate response)

Air Recommendations (General)

1. EMRB is the lead Branch in ambient air monitoring in the Province and manages the program under the umbrella of the Air Quality Management Committee (AQMC) . Do you agree with this arrangement? Yes__ No__

If no, please comment._____

2. Do you agree with recommendation 1? Yes__ No__

If no, please comment._____

3. Do you agree with recommendation 2? Yes__ No__

If no, please comment._____

4. Do you agree with recommendation 3? Yes__ No__

If no, please comment._____

5. Do you support charging a fee for the air quality and emissions data ? Yes__ No__

If no, please comment._____

6. Should the Ministry develop regulations to have industries provide emissions data and to self-monitor for air quality using guidelines developed by this Ministry? Yes__ No__

If no, please comment._____

7. The National Pollution Release Inventory (NPRI) report, expected in early 1995, is likely to show that most pollutant emissions are to the air, suggesting the maintenance of a credible air monitoring program in the province is essential. Do you agree ? Yes__ No__

If no, please comment._____

8. Spatial and temporal interpretation of air quality data requires the integration of meteorology, modelling and emissions with air monitoring. Do you agree this is essential ? Yes__ No__

If no, please comment._____

Additional comments _____

4.30 SURFACE WATER MONITORING

4.31 Purpose of Monitoring

The MOEE role in the management of water resources is identified, primarily in three Ontario Statutes, the Ontario Water Resources Act, the Environmental Protection Act and the Environmental Assessment Act. Although the activity of developing and maintaining monitoring networks to assess the condition of the natural environment is not explicitly cited in the acts, there is sufficient instruction to clearly show that, if the MOEE is to fulfil its mandate successfully, a comprehensive understanding of the state of Ontario's environment is an essential component.

Primarily, the purpose of surface water monitoring is to assess the following:

- Assess potential impacts of existing and proposed waste discharges, land use changes and lakeshore developments;
- Assess the viability of applications for water takings and diversions;
- Provide early warning of undetected or emerging problems and issues;
- Assess compliance with regulatory controls and monitor effectiveness of remedial actions;
- Conduct research into cause-effect relations and assess remedial options;
- Provide environmental data necessary for development of watershed management and land use plans;
- Identify environmental conditions and trends for state of the environment reporting.

Primary client groups which directly depend on surface water monitoring information to meet their responsibilities include:

- Operations Division - for regulatory and effectiveness control

- ESSD Branches - to meet intergovernmental commitments, assess effectiveness, research and state of environment reporting

- The General Public - for reporting on environmental problems, effectiveness and trends

- Other Ministries and Agencies (MNR, Municipalities, Conservation Authorities, OMAFRA, Ontario Hydro, and federal departments - for for planning and meeting international commitments (federal).

4.32 Description of Current Monitoring Efforts

Surface water monitoring presents a significant challenge, not only because of the sheer quantity of surface water in Ontario, but also due to the many forms that surface water takes. This includes the many streams and rivers, the inland lakes and the Great Lakes themselves.

The Ministry of the Environment and Energy currently conducts or oversees about thirty surface water programs that generate data on surface water quality and quantity in rivers and streams, inland lakes, the nearshore zones of the Great Lakes and the connecting channels. Staff totalling about 43 person years, primarily in the EMRB and STB of the Environmental Sciences and Standards Division and Operations Division, plan, oversee the implementation and report on these programs. Their direct operating expense

budgets total about $1.5M (ESSD $1.4M and OD $158K). Substantial additional costs related to sample analysis at the MOEE laboratories ($711K ODOE and 31PY at LSB) and sample collection costs borne by program partners such as MNR, Conservation Authorities, municipalities, industry and cottagers would significantly increase the value of these programs.

Current monitoring programs are carried out primarily to meet:

- Regulatory needs (abatement, approvals, etc.)
- Public expectations and accountability (identification of problems, responding to concerns, SOE reporting, etc.).
- Intergovernmental agreements (COA, Federal/Provincial Hydrometric Agreement, Countdown 94, Niagara River Toxics Management Plan, etc.)
- Local arrangements (i.e., MOEE/MNR, Lake Simcoe, Zebra Mussels, Cottagers Self Help, CURBS)

Existing river and stream monitoring programs in EMRB comprise mainly the Provincial Water Quality Monitoring Network (PWQMN) and the cost shared Streamflow Network, providing specific water quality trend information and effectiveness monitoring. The majority of resources for stream monitoring are housed in ESSD/STB, dedicated to research monitoring to study the effects of long-range air transport and deposition (including acid rain, the study of mercury in the environment and LSEMS and CURBS), special programs for Lake Simcoe and agriculture runoff management.

Inland lake monitoring is conducted primarily by the ESSD/STB and the Operations Division. STB conducts annual monitoring in cooperation with MNR in Lakes Muskoka, Joseph, Rosseau, and Lake Simcoe , and monitors the effects of long range air transport including acid rain on several lakes around the Dorset area. Operations Division monitors the effects of Sudbury emissions around Sudbury lakes, and uses limited resources and cottagers to examine recreational lakes under development pressure.

Great Lakes monitoring programs are conducted mainly in the Great Lakes Areas of Concern (RAP Areas) to assist in the remedial measures assessment and delisting process. Limited investigations are also carried out to provide screening of undetected or emerging problems (i.e., harbours and embayments outside RAP areas) and provide long term sensing at selected sites throughout the lakes on a 4-year cycle.

4.33 Cost of Operation

The following table summarizes the operating costs of surface water monitoring programs for FY1993/94:

Division/Branch	ODOE (K)	PYs
ESSD/EMRB	684	16.5
ESSD/LSB	711	31
ESSD/STB	557	17.8
Operations Division	157.5	8.2
Other/MOEE	133	0.7
Total	2242.5	74.2

* almost 1/2 total monitoring budget — too much

4.34 Gaps, Needs and Options

Phase 1 of the Surface Water review addressed the rationalization of general monitoring activities (i.e., streams, inland lakes, Great Lakes), and recommends adjustments to programs and resources. Phase II will address the gaps and needs for the individual monitoring networks, examining parameters, frequencies, geographic distribution and coverage of environmental stressors and issues (i.e., network rationalization).

Gaps and needs for Phase 1 are reflected in the "Recommended Adjustments" part of Section 4.35. Options for filling the gaps and the requirements for monitoring relate to review of priorities in research monitoring versus operational monitoring and needs allocation of existing resources.

4.35 Recommendations

Using the committee position as documented in the Surface Water report, a comprehensive set of recommendations and activities were developed, that if implemented, will improve the efficiency and client service of surface water monitoring. Recommendations are provided for each component of a monitoring program (i.e., sample collection, analysis, data management, reporting and planning), while actions for implementation can be found in the detailed report.

General Recommendations

- Develop a unifying monitoring framework for stream, inland lakes and Great Lakes monitoring with central co-ordination.
- Clarify roles of the Federal Government versus Province (COA and CCME Harmonization).
- Establish relative priorities and rationalize resource allocations between internal research monitoring and operational monitoring needs.
- Optimize existing monitoring programs and resource allocations (Phase II).
- Assess potential for further integration of similar monitoring programs in MOEE and MNR.
- Develop a data management system with integrating linkages and ready designated client access to all data bases.
- Improve data management and analysis operations/services.
- Establish a new reporting framework to suit client needs.
- Review and optimize sample analysis operations.
- Establish task groups to evaluate and test promising new methods for sample collection and analysis; allocate research funds accordingly.
- Revise the annual and long term planning process.

In addition to the general recommendations listed above, the committee has identified the following recommended adjustments that apply to specific program areas.

Stream Monitoring (Recommended Adjustments)

- Redesign and optimize Provincial Water Quality Monitoring Network (PWQMN) to include:
  - Fixed station network for long term reference
  - Periodic network (5 yr) to meet special commitments (i.e., COA)
  - Variable network (annual) to meet regional regulatory and planning needs

  - Enhanced database analysis and reporting capability to meet OD needs for review and approval functions, including pollution control and land use development

- Rationalize and redesign the streamflow monitoring network with the Federal Gov., MNR, Ontario Hydro (currently ongoing) to meet client needs, including:
  - Long term index station network as base for extrapolation modelling
  - Short term network for regional and multi-agency planning (i.e., development) needs

- Re-establish future capability in EMRB to assist OD in special investigations/monitoring studies (i.e., investigation of spills, waste assimilation, watershed planning, etc.)

Inland Lake Monitoring (Recommended Adjustments)

- Produce and release joint MOEE-MNR management strategies for Lakes Muskoka, Joseph and Rosseau similar to LSEMS
  - Reduce monitoring activity to periodic assessment
  - Establish timelines

- Maintain and promote wider application of the Cottage SELF-HELP programs in Eastern and Mid-Ontario, consider for Northern Region.

- Strengthen regional recreational lakes monitoring programs to meet lake development pressures in Eastern, Mid-Ontario and North Ontario.

- Review monitoring for effectiveness of Countdown Acid Rain and local emission reduction programs in impacted lakes.
  - Set frequencies and timelines to reflect priority of issue

- Establish resources in EMRB for development and implementation of a coordinated framework for inland lake monitoring:
  - Address information gaps for local OD decision making
  - Set up 5 year planning cycle with OD, MNR and MMA to identify and meet local and regional pressures
  - Meet public demand for information related to recreational use
  - Evaluate need for chemical and biological monitoring of wetlands related to development

Great Lakes Monitoring (Recommended Adjustments)

- Work closely with PDB, Federal Gov't, MNR and OMAFRA to develop integrated monitoring programs to meet COA commitments; remaining resources in EMRB are inadequate to meet monitoring needs for:
  - RAP areas delisting
  - Lake Ontario, Erie, Superior/Nipigon Lakewide Management Plans (LaMPs)
  - Field and Marine Operations

- Continue Screening Investigations in areas and issues outside RAP areas to identify existing and emerging issues/problems requiring abatement
    - Clarify and establish roles and responsibilities of EMRB and OD in investigations and abatement
- Continue cycle of Long Term Sensing Site monitoring in support of COA (LaMPs) and SOER
    - Integrate DWSP monitoring data
    - Integrate water intake biomonitoring data
    - Integrate with MNR and Federal Gov't monitoring activities where this is cost-effective
- Re-establish periodic nearshore monitoring program as complement to federal open-lake monitoring, essential for the understanding of the nearshore environment (future)

4.36 Feedback on Surface Water Water Recommendations (Please check appropriate response)

Surface Water Recommendations (General)

1a. Do you support a lead individual to coordinate surface water monitoring programs (including research monitoring)? Yes__ No__

1b. If no, please comment. _____

_____

_____

_____

1c. If yes, who within the MOEE should be the coordinator (Name Branch)? _____

Additional comments _____

_____

_____

_____

2. Do you feel the present resource allocations for research monitoring versus operational monitoring is equitable? Yes__ No__

Additional comments _____

_____

_____

_____

3a. Do you support the establishment of task groups to examine modernization (ie. evaluation and testing of new methods for sample collection and analysis? Yes__ No__

3b. If no, please comment. _____

_____

_____

3c. If yes, who should lead this task group? Name the Branch_____

3d. Should this activity be supported by Research Advisory Committee funding? Yes__ No__

Additional comments _____

_____

4a. Do you agree there is a need to optimize sample analysis operations and services at the lab? Yes__ No__

4b. If no, explain._____

_____

_____

_____

_____

Stream Monitoring

5a. Do you agree that the Provincial Water Quality Monitoring Network (PWQMN) needs to be redesigned and adjusted on an annual basis to meet client needs? Yes__ No__

5b. Do you support enhancing the capability to do more database analysis and reporting for client (especially OD) needs? Yes__ No__

5c. If yes, would you be willing to provide ODOE to maintain/strengthen the network? Yes__ No__

Inland Lakes Monitoring

6a. Do you agree that ESSD should re-establish the capability to assist OD in conducting special surface water investigations for spills, waste assimilation, etc? Yes__ No__

6b. If no, please explain. _____

_____

_____

6c. In conducting research monitoring in Lakes Muskoka, Rosseau and Joseph, do you think that monitoring should be:

1. retained at present level __
2. reduced __
3. enhanced __

Additional comments _____

_____

_____

6d. Do you support the development of management strategies (MNR-MOEE) for these lakes? Yes__ No__

6e. Do you support expanding the cottage self-help programs? Yes__ No__

6f. If no, please explain. _____

_____

_____

_____

_____

6g. Do you support strengthening OD recreational lakes monitoring programs to meet lakeshore development pressures in

Eastern Ontario Yes__ No__
Mid Ontario Yes__ No__
North Ontario Yes__ No__

6h. Can you provide additional resources to do this? Yes__ No__

6i. Monitoring for the effectiveness of countdown Acid Rain needs to be continued at:
the present level Yes__ No__
reduced Yes__ No__
enhanced Yes__ No__

6j. Monitoring for the effects of local emission reduction (Sudbury) needs to be:
maintained Yes__ No__
reduced Yes__ No__
enhanced Yes__ No__

7k. If yes, who should be the coordinator? Name Branch _____

Great Lakes Monitoring

8a. Do you agree that MOEE has a role and responsibility in monitoring in the Great Lakes to meet COA commitments for:
RAPS Yes__ No__
Lakewide management Planss Yes__ No__

8b. If no please explain _____
_____
_____

8c. Would you be willing to provide ODOE/PYs to enhance the present EMRB operations to meet COA commitments? Yes__ No__

8d. Do you agree that MOEE has a responsibility to investigate areas in the Great Lakes that have the potential for new or emerging, or previously undetected problems Yes__ No__

8e. If yes, please explain _____
_____
_____

8f. Do you support the collection of long term sensing information at selected stations in each Great Lake every 4 years in support of COA lakewide management plans? Yes__ No__

Additional comments _____
_____
_____

8g. Do you agree with re-establishing a future MOEE nearshore monitoring program for better understanding the nearshore environment. Yes__ No__

Additional comments

4.40 GROUND WATER MONITORING

4.41 Purpose of Monitoring

Groundwater monitoring is defined as "....the set of activities that provide chemical, physical, geological, biological, and other environmental data needed by managers and decision-makers to assist in developing and implementing groundwater protection policies and programs".

Thus, groundwater monitoring is viewed as a continuum of activities ranging from defining background conditions, to defining the existence and extent of contamination, to defining the success of prevention and response measures and programs to protect the groundwater resources.

Specifically, groundwater monitoring is a means to ensure:

- The fair sharing and conservation of available groundwater;
- The protection of groundwater quality through the prevention of future contamination and the abatement of existing sources of impairment; and
- The provision of adequate information and predictive tools to decision-makers and the public, thus assuring that groundwater issues are appropriately addressed in land and water use planning.

Traditionally, remediation efforts resulting from extensive groundwater contamination are extremely expensive (i.e., Elmira-$25 million, Smithville-$25 million), therefore groundwater monitoring is vital to early detection and remediation.

Clients for groundwater monitoring information include:

- The general public, and numerous non-government organizations.
- MOEE staff (Operations Division; Approvals Branch, IEB and Regions, etc.)
- Numerous other government organization (MOEE, MNR, MMA, CAs, OMAFRA, MOH, MCCS, MTO).
- Municipalities
- Industries (well constructors, planners, developers, etc.)

4.42 Description of Current Monitoring Efforts

In recent years, MOEE groundwater monitoring efforts have been significantly reduced. However, between 1969 and 1986, groundwater efforts were significant and products included:

- b.between 1962 and 1982, a series of 24 drainage basin reports for Southwestern Ontario were published, which included information on groundwater flow systems and hydrochemistry.

- Between 1973 and 1978, MOEE published the major aquifers in Ontario map series, consisting of 8 maps which addressed areal extent and groundwater yield potential for major aquifers of central and eastern Ontario.

- Between 1969 and 1986, a series of 14 groundwater probability maps were published, illustrating potential availability of groundwater for a major portion of southwestern and central Ontario.

MOEE had in place a province-wide network of observation wells to monitor groundwater levels for a variety of uses but currently, only a few of these observation wells are still being maintained by some MOEE Regions.

Between 1972 and 1984, a massive effort was undertaken by the Ministry to identify the geographic coordinates and elevations of the water wells and to create a computerized database, which is known as the MOEE Water Well Information System (WWIS). However, due to current budget constraints WWIS contains approximately 400,000 well records with a backlog of 170,000 well records.

Efforts carried out by Operations Division either directly or indirectly related to groundwater monitoring include:

- Administration of the Permit to Take Water Program under the Ontario Water Resources Act.

- Investigations regarding regional water quantity interference complaints. The scope of data collected depends on the nature of the problem and the local geologic conditions.

- Hydrogeologic studies required prior to recommendation of draft approval for plans of subdivisions and condominiums that obtain their water supplies from individual private wells.

- Investigation and subsequent action related to approximately 2,000 groundwater contamination incidents per year.

4.43 Cost of Operation

The following table summarizes the operating costs of groundwater monitoring programs for fiscal year 1993/94.

Division/Branch	ODOE (K)	PYs
ESSD/EMRB	100	5
Operations Division	20	16
ESSD/LSB	-	-
Other MOEE	-	-
Total	120	21

4.44 Gaps, Needs and Options

Based on the review which the working group conducted, the following gaps and/or needs have been identified:

- Better internal communications within MOEE and with external stakeholders is required for staff who deal with groundwater issues.

- An inter-jurisdictional effort is needed to assemble and computerize the enormous amounts of applicable groundwater data.

- An aquifer mapping program is needed to provide the necessary background information to monitor, manage and protect Ontario's groundwater resources effectively.

- The development of a long-term groundwater quality and quantity monitoring network including a database and designated indicators is required.

- A backlog of about 170,000 well records exist which have not been entered into WWIS and this number is increasing at a rate of between 12,000 to 20,000 records annually.

- Experience indicates that once an aquifer is contaminated, it is extremely difficult to rehabilitate. Therefore, there is a need to continue to protect groundwater quality now and for the future by:
  - focusing on prevention of groundwater contamination rather than remediation.
  - controlling regulated point source discharges and requiring "Best Management Practices" for non-point sources of pollution;
  - developing numerical groundwater limits (maximum allowable concentrations) to be used as a consistent upper limit on the allowable impacts from non-point sources.

4.45 Recommendations

- Establish a multi-jurisdictional groundwater integration group for Ontario, including federal and provincial agencies, conservation authorities, municipalities, academia, and consulting firms. Areas of focus would include:
  - greater integration of monitoring efforts
  - increased computerization and electronic access to groundwater data, including the results of bacteriological and chemical analyses conducted by the health units, the amounts and locations of road salt applications carried out by MTO, etc.

- Cooperation among MOEE staff who deal with groundwater issues should be enhanced through the establishment of an MOEE Standing Committee on Groundwater, and the holding of an annual seminar on groundwater issues.

- Revive the aquifer mapping program, in order to establish a long-term groundwater monitoring program and to effectively manage and protect Ontario's groundwater resources. This should include the development of a priority list of aquifers and watersheds.
  Budget requirements - 3 to 4 additional hydrogeologist and 2 to 3 technicians to be located in EMRB. The Aquifer Mapping Group could recover all expenses through contracts and arrangements with outside clients.

- Establish a long-term groundwater monitoring network that assesses ongoing groundwater quality, establishes sampling protocols and QA programs and develops and maintains an effective data base management system. The network should be established in phases and old piezometers and electronic loggers that were installed should be incorporated into the network.

- Eliminate the backlog of 170,000 well records (increasing by 12,000 to 20,000 records annually). Also need to identify the geographic coordinates and elevations of the wells.
  Budget requirements - Could cover costs by establishing a water well permit fee of $100.00 on every newly constructed well in the province. This could generate between $1.2 to $2.0 million annually and could cover all the costs associated with the groundwater monitoring program.

- It is recommended that GPS equipment (2 units) be purchased for every regional office for an approximate cost of $50,000.00. Such equipment would allow the Regions to identify the geographic coordinates of monitored sites.
  Budget requirements
  Requiring well constructors in Ontario to use GPS equipment to identify and submit new well coordinates would also save money.

- Head office and regional hydrogeologic information and monitoring data (including Permits to take water) should be computerized through a phased-in program. Once computerized, these data should be used to identify broad "groundwater monitoring indicators" (i.e., the number and frequency of public complaints regarding groundwater quantity. Such indicators could shed light on the long-term trends in the depth to the water table, the changes in the demand being placed on groundwater, the stresses being placed on shallow aquifers by surface sources of contamination, the effectiveness of Ontario's buried tanks regulations, and many others.
  Budget requirements
  The budget required to set up the system would be quite large however, it must be started. The following steps are necessary:
  - develop data base system;
  - populate data base as new information is attained through regional requirements;
  - back populate data base using existing hard copy data if resources are available and the quality of data warrants it.

4.46 Feedback on Groundwater Recommendations (Please check appropriate response)

Groundwater Recommendations (General)

1a. Do you support a lead individual to coordinate MOEE groundwater monitoring programs ? Yes__ No__

1b. If no, please comment. _____

_____

_____

_____

1c. If yes, who within the MOEE should be the coordinator (Name Branch)? _____

Additional comments _____

_____

_____

_____

Integration

2a. Do you agree that a multi-jurisdictional groundwater integration group is required to focus groundwater monitoring efforts ? Yes__ No__

2b. Should a Groundwater Standing Committee be set up in MOEE to enhance attention on groundwater issues ? Yes__ No__

2c. Is there agreement that an annual MOEE seminar on groundwater issues, as was the case before 1990, would be useful ? Yes__ No__

Additional comments _____

_____

_____

_____

Program

3a Is it important to revive the/an aquifer mapping program ? Yes__ No__

3b. If yes, would you be willing to provide support with ODOE and/or PYs? Yes__ No__
(Note: All efforts would me made to recover all or part of the expenses through partnerships with outside clients)

3c. Is a long term groundwater monitoring network important? Yes__ No__

3d. If yes, should the MOEE take the lead in its establishment ? Yes__ No__

3e. If yes, who within the MOEE should be the coordinator (Name Branch)? _____

Additional comments _____

_____

_____

_____

Water Well Information System (WWIS)

4a. Is it important that the WWIS be updated ? Yes__ No__

4b. If yes, should the backlog and maintenance of the system be accomplished through ODOE funding? Yes__ No__

4c. Would you be prepared to support WWIS with ODOE assistance? Yes__ No__

4d. Do you agree with the concept of recovering costs through water well permit fees (this would require legislative changes)? Yes__ No__

4e. Would you support the purchase of GPS units for Regional Offices? Yes__ No__

4f. If yes, would you be willing to provide ODOE funds for these purchases? Yes__ No__

4g. Do you agree with the concept that Well Constructors be required to enter well coordinants onto submitted well records (this also would require legislative change)? Yes__ No__

Additional comments _____

_____

_____

_____

Computerization

5a. Should MOEE capture electronically all hydrogeologic information requested for the many assessments that we carry out ? Yes__ No__

5b. If yes, do you support development of a MOEE data base system ? Yes__ No__

5c. If yes, do you support development of a methodology to achieve this capture? Yes__ No__

5d. Would it be worthwhile to back-populate the developed data base with existing hardcopy information currently on file ? Yes__ No__

5e. Would you be prepared to support this with ODOE assistance? Yes__ No__

Additional comments _____

_____

_____

4.50 DRINKING WATER MONITORING

4.51 Purpose of Monitoring

In the review of the drinking water program, discussion is limited to municipal drinking water supplies both from surface and ground water sources, that serve approximately eight and one half million people in the province. The main purpose of the drinking water monitoring program is to secure public confidence by ensuring that the drinking water delivered to the consumer's tap is safe and aesthetically pleasing. In addition, drinking water monitoring is also carried out for the following reasons:

- To determine compliance with Ontario Drinking Water Objectives (ODWOs);
- To determine compliance with minimum treatment policies and minimum sampling programs as outlined in the OWDOs and Certificate of Approval (CofA);
- To investigate through research or surveys, perceived or potential problems;
- To respond to complaints;
- To define cause and effect relationships for remediation;
- To support guideline development when new contaminants are detected;
- To monitor a specific set of indicators over the long term;
- To identify ongoing trends and identify changes in drinking water quality spatially and temporally;
- To provide an early warning for the development of detrimental conditions.

The clients for drinking water monitoring information are both external and internal to MOEE. They include:

- Various divisions of our Ministry, including Operations Division (the Regions and Approvals Branch), the Policy Division (Economic Services Branch and Policy Development Branch and the ESSD (Program Development Branch, Science and Technology Branch and Standards Development Branch);
- The general public.
- Municipalities, industry, consultants and universities;
- Other provincial Ministries such as MOH, MNR, etc.;
- Agencies of the federal and provincial government such as Environment Canada, Health Canada and the Ontario Clean Water Agency (OCWA).

4.52 Description of Current Monitoring Efforts

Ten monitoring programs have been identified as dealing directly or indirectly with the monitoring of drinking water. Sampling is conducted on raw water (prior to treatment), treated water leaving the plant, and distributed water at the consumer's tap. Raw water is sampled because it provides information on the source of contaminants, long term trends in raw water quality, a measure of raw water needed to adjust treatment processes and a measure of treatment efficiency. Sampling of treated water provides information on treatment efficiency and a good measure of the parameters which do not change during distribution, (i.e., pesticides, mercury and PCBs). Distributed water is analyzed in order to provide the best estimate of the quality of the drinking water consumed and information on the parameters expected to change during distribution, (i.e., THMs and metals such as lead).

The monitoring programs can be grouped into the following four basic types:

- Compliance, trends and surveillance monitoring conducted by the Drinking Water Surveillance Program, the Sewage Water Inspection Program and the Radiological Program;
- Specific (one time - one purpose) monitoring conducted by the Intake Sampling Program, the specific Contaminant Response Program and the Special Surveys Program.
- Immediate monitoring conducted by the Ministry of Health Microbiological Testing Program.
- Process control monitoring conducted by the Purveyor Monitoring Program.

Of the ten programs monitoring for drinking water, there are only two known electronic data bases: the Drinking Water Surveillance Program (DWSP) central data base which contains data for up to 180 parameters at 130 sites across the province for up to 8 years and the Utility Monitoring Information System (UMIS) data base which is a mainframe data base containing data collected at 113 OCWA facilities for 14 parameters. The DWSP data base is GIS compatible.

DWSP technical reports are prepared annually on each of the facilities sampled.

4.53 Cost of Operation

The following table outlines the annual costs of the drinking water monitoring program during FY 93/94:

Division/Branch	ODOE (K)	PYs
ESSD/EMRB	175	4
Regional Operations	95	7
ESSD/LSB	600	30
Other MOEE	50	2
TOTAL	920	43

4.54 Gaps, Needs and Options

At the drinking water source, there is a definite need to integrate the surface/ground water quality monitoring programs and the drinking water monitoring program in a manner which facilitates decision making needs regarding abatement and treatment activities and also in order to minimize redundancies in monitoring efforts.

In the treatment and distribution monitoring areas, there is an ongoing need to review the list of parameters and their sampling frequency. There is also a need to allow not only for the monitoring of new contaminants which may arise from source, treatment and distribution processes but for the continued support to undertake analytical and standard development for these new contaminants.

Looking at the drinking water programs in general, there is a severe limitation on the ability to extract, analyze and report on the data electronically, since for the most part DWSP (with the exception of limited data available through UMIS) is the only electronic data base available. In terms of sampling, there is a shortfall in the total number of facilities which are actually sampled.

In addition to the above generalized gaps, the following gaps have been identified according to the various program:

Certificate of Approval Program

- There is no evaluation of sampling requirements or data.
- No data base for data requested from purveyor.

Drinking Water Surveillance Program

- Very few homes in each system are sampled
- Sampling restricted due to limited LSB capacity

Sewage Water Inspection Program

- No homes are sampled
- Monitoring requirements only consistent with ODWOs recommended minimum sampling.

UMIS Program

- Limitation on the number of parameters sampled
- No data verification

Radiological Program

- Sampling limited to locations near nuclear facilities

Options

The drinking water monitoring review committee has developed three options for monitoring drinking water in the province that would still retain the outputs of an effective monitoring program. In all three options considered, DWSP is the main program since it addresses all aspects of drinking water monitoring and it has a comprehensive data base. The options are as follows:

Option 1

- DWSP continues to sample the 130 water supply systems while adding 25 new facilities each year over the next 15 years.
- DWSP takes over the SWIP lab load allocation, enhances the site specific analyses in order to reduce the number of non-detects and finally captures the taste and odour complaint information.
- Radiological and MOH data are made compatible with each other and DWSP.
- The municipal purveyor would retain its own data results. Updated C of A for all locations would be phased in over the 15 years.
- SWIP continue inspections using DWSP results.
- UMIS would continue with monthly summaries of 14 parameters at the 113 OCWA plants.

This option requires minor program changes and no additional resources for the first three years. Lab load allocation would have to be increased after the third year.

Option 2

- DWSP to immediately cease monitoring at 100 water supply plants which have two years of data. This would leave 25 plants currently being sampled and add 25 per year over the next 15 years. There would be a maximum 50 facilities on DWSP at any one time. After 2 years sampling, plants are dropped permanently from DWSP. Plants dropped would not be sampled again as part of DWSP except for exotic parameters (i.e., radiological, GC/MS characterization and new parameters). The municipal purveyor will be in partnership with the MOEE and would sample for ODWOs when DWSP stops sampling. In order for DWSP to accept the data results, they must be analyzed by an accredited lab supporting acceptable quality assurance and control procedures.
- DWSP takes over the SWIP lab load allocation, enhances site specific analyses in order to reduce the number of non-detects and captures the taste and odour complaint information.
- radiological data and MOH data are made compatible with DWSP.
- SWIP continues inspections using DWSP results
- UMIS will be phased out and replaced by automated MBR reports.

This option would require resources for private lab accreditation and necessary QA/QC to ensure purveyor's data is comparable to DWSP.

Option 3

- As in **Option 2** , DWSP drops 100 plants immediately, but adds 100 new locations annually. DWSP would conduct intensive sampling for two years before dropping a location. All locations would rotate onto DWSP on a 6 year cycle.
- SWIP would increase to yearly inspections. C of A monitoring requirements would increase and all locations would be phased in over 5 years.
- UMIS phased out and automated MBR reports by DWSP
- Radiological data and MOH data are made compatible with DWSP
- Municipal purveyor would be in partnership with DWSP. When a location is not on DWSP, purveyor would sample for ODWOs.

This option contains a major change in direction with substantial additional resources required. It would result in greater confidence in a shorter time frame.

4.55 Recommendations

1. In order to achieve the optimum confidence regarding the safety of drinking water and answer the typical questions and needs of the MOEE Branches and Divisions, **Option 1** is recommended.

2. MOEE should consider a feasibility study leading toward the adoption of **Option 2**.

3. MOEE should accept, and explore further, the concepts suggested in Chapter 8 on the Future Program -A Vision for Monitoring (see main Drinking Water Monitoring review document); this is essentially a continuance of Option 2 with various distributed data bases being accepted, possibly after further feasibility studies, for MOEE use and analysis.

4.56 Feedback on Drinking Water Recommendations (Please check appropriate response)

Drinking Water Recommendations (General)

1a. Do you support a lead individual to coordinate drinking water monitoring programs ?
Yes__ No__

1b. If no, please comment. _____

_____

_____

_____

1c. If yes, who within the MOEE should be the coordinator (Name Branch)? _____

Additional comments _____

_____

_____

_____

Options

2a. Do you agree that option 1 is the optimum choice regarding confidence in the safety of drinking water quality? Yes__ No__

2b. Does option 1 best address the ability to answer questions related to treatment efficiency, data for standard setting, and seasonal/geographic/distribution changes? Yes__ No__

2c. If no, please comment. _____

_____

_____

2d. Should MOEE move towards eventual adoption of option 2? Yes__ No__

2e. If no, please comment. _____

_____

_____

2f. Do you agree with the need for a feasibility study for this? Yes__ No__

2g. Would you be willing to provide ODOE funds to assist this study? Yes__ No__

Additional comments _____

_____

_____

_____

_____

_____

3a. Do you accept the long-term concept of distributed monitoring, which is quality controlled before entry into MOEE databases? Yes__ No__

3b. If no, please comment. _____

3c. Should the MOEE actively pursue this concept through a more in-depth feasibility study than in 2d. above? Yes__ No__

3d. Would you be willing to provide ODOE funds to assist this study? Yes__ No__

Additional comments _____

4.60 BIOMONITORING

4.61 Purpose of Monitoring

Biomonitoring is best described as the use of living organisms or "biota", to assess environmental quality. Monitoring is carried out for the following reasons:

- Monitoring of living organisms provides direct, irrefutable measures of *adverse effects*;
- Living organisms integrate impacts from various sources and environmental stresses on their ecosystem; that is, their behaviour can reflect combinations of stresses simultaneously. They also integrate the impacts of temporal variations in emissions and discharges;
- Biota respond to a variety of different chemical, physical and biological insults often at levels below existing analytical detection limits. As a result biological monitoring can reduce the time and cost involved in environmental impact assessment;
- A small change detected in one organism may alert us to greater change elsewhere in the food web;
- The public best understands environmental change as measured by effects on the plants and animals which they see around them; and,
- Living organisms are the best indicators of the overall health of the natural environment and in affording this type of protection, we can provide even greater assurance of safety for humans.

These reasons remain valid in the 1990's and are reflected in legislative authority under which environmental protection is provided (e.g., the *Environmental Protection Act* adverse effects provision) and in the MOEE mandate. Taking advantage of the above strengths, MOEE biomonitoring programs have, over the past 25 years, provided the MOEE and its clients with sound information upon which to assess their surroundings and make decisions on future environmental programs.

Clients for biomonitoring data include:

- MOEE staff, including Operations division, Approvals, IEB, etc.;
- Municipalities, industry, academia, consultants;
- The general public, numerous non-governmental organizations; and,
- Other government agencies including agencies of the federal and provincial governments of Canada, the US Environmental Protection Agency and various US state agencies.

4.62 Assessment of Current Biomonitoring Programs

Reflecting the direct, health-related concerns of the residents of Ontario, more than half of the biomonitoring programs conducted by the MOEE focus on emissions/discharges of toxic substances, in particular, bioaccumulation of persistent toxic contaminants. The Ministry monitors contamination in sport and forage fish, aquatic invertebrates, terrestrial vegetation and algae. A wide range of metals and organics are analyzed in samples collected in support of point source investigations and ambient monitoring. However, only five biomonitoring programs provide measurements of contaminant trends

over at least five years. During the 1970's and into the early 1980's, these surveys showed significant, if not dramatic declines in contaminant levels in numerous species monitored in the vicinity of known or suspected sources of contamination. Since the mid-1980's however, those declines have slowed and in a few cases been reversed. At the same time that contaminant levels remain above existing guidelines in many areas and for numerous species. To reduce exposure to contaminants, the Ministry must seek out the remaining dispersed sources of these contaminants and assess their impact on Ontario ecosystems. The Ministry must also look beyond the current list of substances for which it monitors.

Monitoring of water bodies for the impact on biota of nutrient enrichment, due mainly to phosphorus discharges from sewage treatment plants, private septic systems and run-off from farmland, constitutes the second most common type of biomonitoring in the province. Whereas monitoring of the Great Lakes, the interconnecting channels and a number of inland lakes is considered adequate, nutrient enrichment of rivers, streams is not monitored efficiently. Greater use of biomonitoring tools should be used to focus the Ministry's lake, river and stream monitoring and remedial programs.

The Ministry invests significantly less resources in monitoring of environmental impacts on the physical habitats of organisms. These environmental impacts include particulate discharges/emissions, exotic species invasions, temperature impacts (including global warming), and hydrological alterations. The persistent or repeated impact of these stresses, alone or in combination can lead to the exclusion of one or more species from an ecosystem. Current efforts are concentrated in specific geographical areas or limited to a small range of species.

There are a number of biomonitoring programs which provide data to assess the impacts and potential recovery from acidification-related issues. These types of long term data sets are extremely rare and could also be used to monitor the impacts of environmental stresses such as habitat alterations, UVB exposure and climate change.

With a few notable exceptions, data storage in the Ministry is considered out-dated. Much of the data, for instance, that is needed for state-of-the-environment reporting is difficult to retrieve as it is in either antiquated storage formats or in paper files that have been archived.

Finally, there remains an ongoing need for support for biomonitoring programs in the form of new biological standards and interpretative guidelines, better laboratory analytical methods, including lower detection limits, and development of new biomonitoring methods that offer lower field and laboratory costs.

4.63 Cost of Operation

The following table summarizes the operating costs of the biomonitoring program during FY93/94.

Division/Branch	ODOE (K) *	Person Years
ESSD/EMRB	310	10
Other ESSD Branches	290	15.5
Lab Services Branch	180	22
Operations Division **	-	0.5
TOTAL	780	48

* costs shown in this column also include costs associated with the collection of non-biological samples since costs cannot be separated cleanly where both chemistry and biological samples are collected in the course of the same survey

** costs shown here are only those associated with BioMAP. Other costs, including those associated with routine monitoring of point sources are not included.

4.64 Gaps, Needs and Options

The biomonitoring working group committee identified needs in the following areas:

- **Biomonitoring-based screening programs** to identify environmental problems before damage becomes critical or irreversible; that seek out the dispersed sources that continue to contaminate natural ecosystems, and to better focus regular ongoing (media-specific) MOEE monitoring programs. Examples of biomonitoring "tools" that would form the basis of such screening programs include benthic macroinvertebrate community assessments (e.g., BioMAP in southwestern Ontario), the use of forage and sport fish for measurement of a range of contaminants in their immediate environment and the use of moss bags to provide a simple integration of air quality in an area;
- **Long-term biomonitoring** to provide information in order to determine progress towards achieving Ministry goals. Long-term biomonitoring is essential to SOE reporting;
- **Data accessibility** to clients both within and outside the Ministry;
- **Additional standards and guideline development** for observable biological effects such as lethality, growth, reproduction and community structure.
- **Enhanced analytical support** for measuring concentrations of newly discovered contaminants and lower detection limits for a number known substances;
- Supporting **research and development**.

Based on the above needs, the biomonitoring committee has developed the following two options:

OPTION 1

Implement changes recommended for each **existing** program. Several specific examples, drawn for the report, are listed below:

- Implement changes to the display of fish consumption advisories in the next *Guide to Eating Ontario Sport Fish*;
- Archive phytoplankton samples collected under the Great Lakes Intakes Program. Seek outside financial support for their analyses;
- Develop new laboratory analysis methodologies to meet emerging needs; e.g., co-planar PCB analyses, photo-mirex. Develop new methodologies that achieve lower analytical detection limits for various organic compounds in biota (e.g., toxaphenes in fish);
- Reduce the number of vegetation and soils investigations where there is little scientific grounds for the (public) request; e.g., where the request is made largely to resolve specific disputes between neighbours or in support of real estate transactions;
- Capture historical (e.g., complaint-related) data into Phytotoxicology Information Management System (PIMS) for SOER and other public information needs;
- Better prioritize monitoring under RAPs;
- To ensure efficient, cost-effective biomonitoring efforts, conduct a program-by-program efficiency assessment review to determine optimal sampling designs, with appropriate sampling frequency and effort, and to ensure sufficient statistical power to detect ecologically important changes and long-term trends in reliable biological indicators; and,
- Continue to seek out new biomonitors that offer potentially lower costs.

This option is best be described as housekeeping/efficiency changes with little in the way of radical change - building on existing strengths.

OPTION 2

In addition to the recommended changes in Option 1, coordinate and where necessary, expand biomonitoring programs across southern Ontario to provide the screening capability essential for sound environmental management in Ontario and the long-term monitoring data needed for state-of-the-environment monitoring, for both terrestrial and aquatic ecosystems by:

(a) Developing a southern Ontario inland waters screening network that builds on the strengths, and uses as potential models the various benthic invertebrate and other aqueous ecosystem screening programs such as sport and forage fish sampling and liver enzyme induction bioassay programs already in place. This network would complement and mesh with similar work already under way in the Great Lakes and Interconnecting Channels. Such a network would be developed with the intent, or at least the possibility, that it be implemented at the field level by either volunteers or by conservation authority staff, with coordination and scientific guidance by MOEE staff. As first steps toward the development of such a program, MOEE staff (possibly those who met as the Biomonitoring Program Review) would:

- Meet with staff of other Ministries and other levels of government who have a stake in such a program to seek their cooperation and buy-in with respect to resources or at least in-kind cooperation; and,
- Establish a committed nucleus of MOEE staff with the essential knowledge who would guide implementation of such a program in an MOEE region other than the Southwestern Region (based on the assumption that BioMAP will continue in the London region in 1995).

(b) Committing support to the Environment Canada led Ecological Science Centres initiative or developing a terrestrial component for the above described aquatic network; and,

(c) Developing new biological standards or guidelines.

This option should be resource-neutral through the cooperation of outside parties and through a reduction in the number of routine surveys and programs now carried out by ESSD staff. However, if additional resources are needed to achieve the programs goals, these should be sought through re-deployment of resources from lower priority monitoring activities in the Ministry.

4.65 Recommendation

The Biomonitoring Review Committee recommends acceptance of **Option 2** which entails a re-direction of a significant portion of the current biomonitoring-related resources, away from routine survey work, towards screening surveys, to provide better early warning information and more long-term monitoring in support of State-of-the-Environment reporting. The guiding philosophy in reducing or eliminating surveys would be that with the exception of long-term reference sites, no survey would be conducted where the results are largely predictable.

4.66 Feedback on Biomonitoring Recommendations (Please check appropriate response)

Biomonitoring (General)

1a. Coordination of biomonitoring activities is currently provided for known point sources by the Operations Division. Coordination of province-wide ambient monitoring is provided by ESSD. Do you agree with this approach? Yes__ No__

1b. If not, what changes would you like to see?

Comments. _____

2. Do you agree with option 1? Yes__ No__

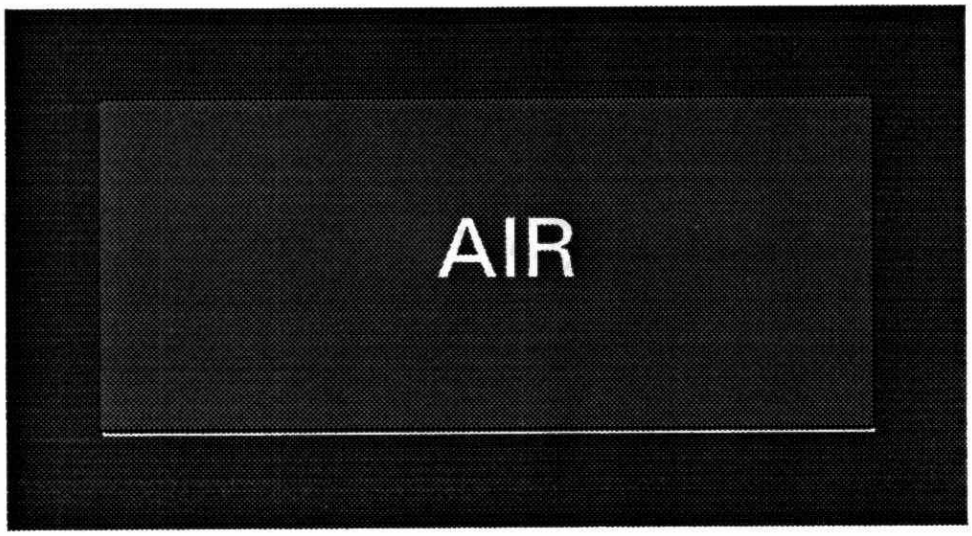
Comments _____

3. Do you agree with option 2? Yes__ No__

Comments _____

Additional comments _____

MONITORING REVIEW



NOVEMBER 1994

AIR MONITORING PROGRAM REVIEW

SECOND DRAFT
NOVEMBER 24, 1994

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1. PURPOSE OF THE REPORT

The Environmental Sciences and Standards Division (ESSD) of the Ministry was reorganized in November 1993 with a multi-media focus. Most of the environmental monitoring sections were made part of a single branch (Environmental Monitoring and Reporting Branch (EMRB)) and the individual media specific monitoring program leaders were charged to review their programs with a view towards multi-media integration and reporting.

The goals and objectives of monitoring and reporting in the new organization and the generic terms of reference for the work groups (five workgroups related to the monitoring programs; e.g., Air Monitoring, Surface Water, Bio-Monitoring, Drinking Water and Ground Water) are as follows:

Goals and Objectives of Monitoring/Reporting
Approach to Monitoring/Reporting

Goal

To monitor, assess and report on the state of the environment in support of informed decision-making that leads towards the restoration and maintenance of the province's ecosystems.

*** Objectives**

a. The Ministry will focus its monitoring and reporting efforts to assess the state of Ontario's environment by utilizing environmental and compliance monitoring.

b. The Ministry will contribute towards sustainability reporting by integrating reporting on the state of the environment with the broader economic and social issues.

c. The Ministry will provide information on the state of the environment to be used as an integral part of Ministry, and inter-Ministry priority-setting for environmental protection.

d. The Ministry will take a leadership role with other Ontario Ministries and jurisdictions in the development of a truly integrated provincial monitoring and reporting framework.

e. The Ministry will work with the other provinces and the Federal government in the development of a national monitoring and reporting system.

Terms of Reference

Using the goals and objectives of monitoring and reporting as the focus, the program review process will assess existing EMRB monitoring programs and their tie-in with other ESSD Branches monitoring efforts, and determine/recommend future directions for monitoring in the province. This will be accomplished by:

- reviewing existing monitoring activities to identify current monitoring initiatives, client needs, data and reporting requirements.

- identifying monitoring gaps and needs, including resource impacts.

- providing options and giving recommendations for future monitoring directions, addressing the need for integration of monitoring efforts, data optimization, partnerships and effective reporting.

A list of the members of the Air Monitoring Work Group is shown in Table 1.

TABLE 1	
Air Monitoring Work Group	
P.K. Misra (Chair)	EMRB
Gary De Brou	EMRB
Bev Hanna Thorpe	SDB
Walter Chan	STB
Neville Reid	STB
David Yap	EMRB
Peter Wong	EMRB
Dan Toner	LSB
Dennis Griffin	Northern Ontario Region
Denis Corr	West Central Region

2. RATIONALE FOR MONITORING

2.1 Monitoring Objectives

An ecosystem is defined as the complex of a community and its environment functioning as an ecological unit in nature. The Ministry is committed to an ecosystem approach to environmental protection and resource management. Here the ecosystem is viewed as composed of air, land, water, and living organisms, including humans, and the interactions among them. Decision-making with this approach considers the cumulative effects on the environment, the interdependence of air, land, water and living organisms and the interrelationships among the environment, the economy and society.

Monitoring the trends in environmental pollutant loadings to the air, water and soil is an important part of ecosystem study. The air monitoring program of the Ministry of Environment and Energy is designed to monitor air pollutants, as well as to obtain some information on the deposition of pollutants to the terrestrial and aquatic environments. It also permits understanding and determination of trends. With some modifications, it is ideally suited to providing input to the ecosystem monitoring anywhere in the province. The other important objectives of the air monitoring program are to:

- Inform the public of their outdoor air quality on a real-time basis so they can respond appropriately to pollutant levels.

- Provide an episode warning and control mechanism for the protection of human health.

- Assess the quality of the air in Ontario and evaluate trends; identifying areas of non-attainment and identifying the origin of pollutants.

- Assess the effectiveness of pollution abatement activities.
- Provide data for compliance and complaints investigations.
- Trigger immediate compliance action.
- Provide the basis for the development of air management strategies.
- Provide quantitative measurements for abatement action.
- Assist in demonstrating that U.S. sources cause problems in Ontario.
- Enable the setting of meaningful air quality criteria.
- Provide information on the interaction between the various media.
- Assist in the assessment of ecosystem damage caused by air pollution; support research activities on ecosystem.
- Support other networks.
- Providing data for compliance/complaints investigations.
- Providing the basis for the development of air management strategies.
- Providing quantitative measurements for abatement action on specific sources.
- Enabling the setting of meaningful air quality criteria.

- Assisting in the assessment of ecosystem damage caused by air pollution and supporting research on ecosystems.

More detailed description of the existing and future monitoring objectives is given in Section 4.

2.2 Program Elements

The various elements of the air monitoring program are:

- **Collection of Data**
  - Ambient Stations
  - Telemetry System
  - Source Surveys
  - Quality Assurance
  - Meteorological Data via Satellite Link.

- **Data Bases**
  - AQUIS (Air Quality Information System)
  - MDAS (Meteorological Data Acquisition System)
  - Relational Data Base for Source Data.

- **Analyses and Assessment**

  - Trend Analyses
  - Annual Air Quality Report
  - Integration using Models
  - Source-Receptor Analyses
  - Compliance/Complaints Investigation

- **Public Information per Regulations (Forecasting)**

    - AQI (Air Quality Index)
    - API (Air Pollution Index)
    - LIMA (Lambton Industry Meteorological Alert)
    - Air Quality Advisory.

The air data related to the above mentioned program elements are:

- **Ambient Monitoring Data**
  (e.g. SO_2, CO, ...)

- **Source Data**
  (e.g. SO_2, CO, ...)

- **Meteorological Data**
  (e.g. winds, precipitation, temperature .....)

- **Quality Assurance/Quality Control of Data**
  (e.g. corrections, failure rates .....)

- **Supporting Data**
    - Statistics Canada Data
    - Geophysical Data

The relationship of the above program elements to the issues within the Ministry is shown in Table 2. One of the important criteria of a monitoring program is to possess the flexibility to change to meet the needs of a new issue. The air monitoring program allows that flexibility.

TABLE 2				
	ACTIVITIES			
AIR ISSUES	MONITORING	ANALYSES & REPORTING	EMISSION INVENTORY	PUBLIC INFORMATION
GLOBAL WARMING/ CLIMATE CHANGE		X	X	
URBAN AIR QUALITY/SMOG/ GROUND LEVEL OZONE	X	X	X	X
STRATOSPHERIC OZONE/UV-B RAD.		X	X	X
AIR PARTICULATES (HEALTH)	X	X	X	X
AESTHETICS (ODOUR/VISIBILITY)	X	X	X	X
TOXICS	X	X	X	
ACID DEPOSITION	X	X	X	
INPUT TO ECOSYSTEM STUDIES	X	X	X	

2.3 Clients

The following is a list of the clients of the air monitoring program and examples of the benefits of the monitored data to them.

CLIENTS	BENEFITS
Public (including media)	Provide data on health effects
Regional abatement staff	Complaint investigations
Industry	Environmental awareness & information (e.g., State of the Environment reports)
Municipalities	Supports approvals process
Investigation & Enforcement staff	Verification of emission inventories and stack testing
Medical Officers of Health	Verification of models
Ministry of Labour	QA/QC service (for non-MOE networks)
Federal government (e.g., NAPS, "smog"), adjacent Canadian Provincial and U.S. environmental agencies (including IJC)	Supports national data base in exchange for equipment
Emergency response staff	Supports standards and regulation development
Environmental interest groups	Provides funds for regional air monitoring equipment needs
Consultants	Supports large-scale special studies (e.g. Windsor)
Water resources staff	Supports policy and program development
Education/research institutions	
Utility Operations, Approvals. other branches	

3. METEOROLOGICAL INFLUENCES ON AIR QUALITY IN ONTARIO

3.1 Introduction

Man-made and natural emissions of contaminants into the atmosphere on local, regional, continental, and global scales and their atmospheric interactions determine the quality of air at receptor locations. Locally, the air quality at a receptor is often greatly influenced by its proximity to area sources such as automobile emissions and industrial fugitive emissions and to nearby upwind point sources with elevated stack emissions, and existing meteorological conditions. For contaminants that undergo long range transport and transformation such as acidic species, tropospheric ozone, trace metals, etc., distant large sources are significant contributors to local air quality, and the atmospheric interactions are such that levels are strongly linked to synoptic weather patterns and regional scale meteorology. The resultant air quality in Ontario is thus strongly affected by meteorology on the various space scales: large scale, mesoscale and local or microscale.

3.2 Large-scale Meteorological Influences

Air quality problems such as photochemical smog (ground-level ozone) and acidic air/precipitation in Ontario are strongly linked to large-scale meteorology. In addition, stagnation periods and local accumulation of air pollutants are associated with the large scale synoptic weather patterns.

3.3 Ground-level Ozone

Ground-level ozone is normally a component of photochemical smog in which nitrogen oxides and hydrocarbons (volatile organic compounds) react in the

presence of sunlight. It is not directly emitted into the atmosphere in significant amounts but rather tends to be formed downwind of precursor sources and is capable of travelling long distances through the atmosphere. As a result, ozone is often a manifestation of long range transport of air pollution.

Episodes of elevated ozone in large regions of eastern North America usually occur between May and September. They are associated with high pressure systems which move south out of central Canada into the Midwest of the U.S. or the Great Lakes area and then eastward to the Atlantic Coast. The frequency of ozone episodes varies and depends on large-scale weather patterns. For example, "episode days" (days with widespread elevated ozone levels greater than 80 ppb maximum hourly concentration) in southern Ontario occurred on average 15 days per year from 1979 to 1992, with a maximum of 36 days, and a minimum of 7.

On ozone episode days air parcels generally reach southern Ontario from the south or southwest, crossing over heavily industrialized and urban areas of the U.S., which are potential source regions of ozone and its precursors. Meteorological analysis thus strongly implicates emission sources in the United States as major contributors to high ozone in Ontario. Summer heat waves in Ontario are often accompanied by southerly flow of humid air from the Gulf of Mexico resulting in smoggy conditions (including elevated ozone levels).

3.4 Acidic Aerosol/Precipitation

Over the past several decades, the use of tall stacks, coupled with high emissions from fossil fuel combustion has resulted in the acid rain phenomenon. Because acid pollutants undergo long-range transport and transformation, they can travel hundreds of kilometers before being deposited in Ontario.

Most of southern and central Ontario receive more than 20 kilograms per hectare per year of sulphate in precipitation, levels that are considered potentially harmful to sensitive water bodies. Investigations have linked southerly air flows into Ontario to high atmospheric concentrations of several pollutants, and high acidity in precipitation. The U.S. contribution is estimated to be about 50 per cent of the sulphate deposited in the province.

3.5 Stagnation Periods

In Ontario, prolonged periods of light winds are normally associated with large slow moving high pressure cells. When such situations are coupled with intense low level inversions and limited vertical mixing, "stagnation" conditions develop and air pollutants (especially suspended particulate matter) tend to build up locally. This situation typically occurs in the fall ("Indian summer" weather) and sometimes in the winter during a sudden thawing period. It can lead to undesirable air quality in the major urban centres of southern Ontario as emissions from the multitude of low level sources (cars, space heating sources, factories, etc.) are trapped near the ground for a number of days.

3.6 Mesoscale Meteorological Influences

In Ontario, the Great Lakes significantly influence the local surroundings. When warm southerly air masses move northward and pass over the relatively cold water of the Great Lakes, the air mass is modified, creating a condition which can strengthen the temperature inversion in the lower atmosphere. This commonly occurs in late spring and summer and often results in trapping of air pollutants and an overall deterioration in air quality.

3.7 Local/Microscale

On the local scale, meteorology exerts a major influence on air quality levels. Air pollutant levels are affected by winds which transport and disperse pollutants emitted from local sources; by ambient temperature which affects the amount of fuel used and the chemical reactions in the atmosphere; by the stability of the atmosphere which affects the dispersion of contaminants; by precipitation which may remove pollutants from the atmosphere; and by sunshine which causes photochemical reactions of air pollutants and leads to local formation of smog.

Topographical features, such as valleys and ridges can create local climates, which affect air quality. Stagnating air in valleys can lead to local accumulation of air contaminants.

In urban areas, buildings give rise to urban canyon circulations and the trapping of pollutants locally. The nocturnal urban heat island phenomenon where night-time temperatures in cities tend to be higher than those in surrounding rural areas, results in limited vertical mixing and can lead to the build up of air pollution.

Meteorological Controls in Selected Problem Areas in Ontario

3.8 Particulate Levels in Hamilton

Airborne particulates are a major pollution problem in Hamilton. The industrial complex beside Hamilton Harbour is a major source of heat and pollution which affect the local environment.

The climate of Hamilton is moderated by its proximity to Lake Ontario. Lake induced inversions are common in the spring and fall and sometimes result in severe fumigations over parts of the city. Topographical influences include the Dundas valley and the Niagara escarpment. Hamilton is an example of the combination of factors in which the Niagara escarpment interacts with the lake breeze, advection inversion, and an urban heat island to frequently cause high pollutant levels.

3.9 Carbon Monoxide Levels in Downtown Toronto

Short-term levels of carbon monoxide in downtown Toronto are typically the highest recorded in the province. Such elevated levels can be related to several factors, including the volume of traffic, urban topographic effects and local meteorological conditions. Automobile emissions are the major source of carbon monoxide in large urban areas and tend to be highest during the morning and evening rush hours, and on weekend nights. In downtown Toronto, violations of the 1-hour and 8-hour provincial air quality criteria occur mostly during weekend nights in the summer months.

The prevailing meteorological conditions during high carbon monoxide events are calm or very light winds and a very stable atmosphere. Typically, the morning rush hour emissions occur at a time of light wind conditions and limited vertical mixing and dispersion, resulting in the build up of pollutant levels.

Urban topography also affects carbon monoxide patterns. Urban street canyon, building shadowing, and air flow blocking are examples in which large buildings and structures create unique micrometeorology and microclimate. In downtown

Toronto, this situation does not favour pollutant dispersion.

3.10 Sulphur Dioxide levels in Sudbury

In Sudbury, sulphur dioxide has been the contaminant of greatest concern as a result of emissions from the Inco and Falconbridge nickel smelters. Inco's "tall" stack, erected in 1972, releases pollutants at great heights, dispersing them over a wide area. This has resulted in lower average sulphur dioxide levels locally, and fewer exceedances of the provincial air quality critieria. The problem of short-term fumigations, however, has not been completely eliminated. On sunny spring and summer days when considerable convective activity and "looping" plume behaviour occur, tall stacks usually produce their maximum ground level concentrations. Thus in Sudbury, the frequency of such occurrences generally increases in the spring and summer months.

3.11 Sulphur Dioxide Levels in the Sarnia Area

In the Sarnia area, sulphur dioxide pollution is also of concern. Chemical and oil refineries and large thermal generating stations are the major emission sources. The Sarnia area is flat and is bounded by Lake Huron on the north and the St. Clair River on the west. The river channels air flow and hence emissions from industries along its banks. The situation is exacerbated as both the river and industries are aligned in the direction of the prevailing southwest winds.

The importance of meteorology in controlling air pollution in the Sarnia-Lambton airshed is embodied in a special regulation (Regulation 350) called the Lambton Industry Meteorological Alert. This regulation, introduced in 1981, requires reduction in sulphur dioxide emissions when adverse meteorological conditions are expected to persist.

3.12 Total Reduced Sulphur Levels in Ontario

Reduced sulphur compounds are emitted from a number of industrial sources in Ontario, including pulp and paper mills, the iron and steel industries and refineries. Local meteorological conditions, particularly wind direction, are critical in governing what areas will be impacted. Also, the impact is greatest at night or early morning during weather inversions.

3.13 Climate Change: Impact on Air Quality in Ontario

Best estimates suggest that emissions of "greenhouse gases" will cause world temperatures to increase by 0.2 to 0.5 C per decade.

In Ontario, the impact of climate change on air quality could lead to increased emissions of ozone precursors, increased photochemical activity, leading to more severe ozone episodes. Predicted changes to the global air circulation pattern may also result in more episodes of high ozone in Ontario.

Climate warming could also have an impact on acid rain, both regionally and globally. It has been suggested that this would exacerbate the already serious effects of acid rain.

The interactions between climate change and environmental problems contain many uncertainties. For example, there are other implications to the acidification issue. Sulphur dioxide emissions have a direct effect on radiation absorption via the aerosol route and an indirect effect via cloud formation. Acid deposition may lead to significant formation of nitrates in the soil, thereby

reducing methane decomposition capacity and increasing nitrous oxide

production. Nitrogen deposition may also lead to higher biomass production in the oceans. Air quality (reflecting the composition of the atmosphere), climate and ecosystems are thus all inter-related.

Air monitoring data could, therefore, be potentially used as indicators of climate change.

4. AIR QUALITY MONITORING OBJECTIVES

The present and some possible future objectives of air quality monitoring, from various points of view, will be discussed in this section. In addition to uses of air quality monitoring data, noted elsewhere in this report, this section will discuss the objectives from the following points of view:

- Health Studies
- Terrestrial Effects Studies
- Public Information (AQI)
- Compliance with Regulation (API/LIMA)
- Input to Ecosystem Health Assessment
- State of the Environment Reporting
- Client Needs

4.1 Health Studies

Present objectives:

Air monitoring provides data for the assessment of human health effects of air pollutants. Acute health effects manifest themselves in a few hours to a few days following exposure. Chronic effects are associated with long-term exposure. Air pollutants can also be deposited on water, soil and vegetation and be taken up in the food chain, thereby exerting indirect effects. The health effects for air contaminants may be well known, merely suspected or the knowledge base may not be well developed. Some substances in air may not be of direct concern but they may be precursors to toxic air contaminants via atmospheric transformation. In some cases, the original factors for undertaking monitoring may have changed and new ones emerged.

The present air monitoring objectives related to human health are to provide data:

- For urban, rural, and background situations for comparison to health-based criteria.

- In source-specific situations for comparison with health-based standards and compliance with regulations, policies and control orders, or to ascertain the seriousness of a problem.

- For epidemiological investigations, such as exploring possible linkages with cancer.

- For investigating associations between directly measurable health variables (eg., elementary school absenteeism, hospital admissions, respiratory health and pulmonary function effects and mortality) and low to moderate levels of criteria pollutants (eg., ozone, inhalable particulates - PM_{10}, sulphate and acid aerosols,).

- For estimating population exposure in relation to existing or proposed air quality standards. Air monitoring data, together with monitoring data from other media, provide a picture of total exposure and the relative importance of the contributions of the various environmental media to total population exposure.

- To estimate potential cancer and non-cancer risk for a population in a specific airshed. Data may provide input to stake-holder decisions to reduce risks in the most cost-effective manner.

- As possible early warning for substances which have recently been implicated as having potential health risks.

- As a 'reality check' for atmospheric modelling, in situations where modelling is used to estimate health risks over large areas.

- To compare different cities, different microenvironments (e.g., between indoor and outdoor air), etc.

Possible future objectives:

For some pollutants (eg., ozone, fine particulates, acid aerosols) emerging health effects data indicate that short-term elevated levels may be significant. This points to the need for characterizing environmental levels over shorter time periods and on a real-time basis. Other pollutants are normally associated with effects from relatively constant daily exposures over a lifetime. Questions are now being asked about their possible short-term health effects (eg., vinyl chloride around landfill sites, nitroso-dimethyl amine (NDMA) emissions from rubber product manufacturing plants, benzene near gasoline handling facilities). While modelling of such exposures may provide answers to this, only real-time monitoring data can provide input to validate these models.

Current regulatory practices for toxic air pollutants target the sources of direct emissions. However, some toxic air pollutants can be formed in the atmosphere. It is estimated that such formation contributes as much as 85% of the ambient levels of formaldehyde and 95% for acetaldehyde. There are two situations of concern with toxic transformation products: when an *emitted* toxic pollutant is converted to a more toxic air pollutant, and when an innocuous emitted pollutant is converted to a toxic air contaminant. An example of the latter is the conversion of propylene to acetaldehyde which in turn produces formaldehyde and peroxyacetyl nitrate (PAN). Thus, future routine monitoring may have to develop methods for measuring toxic secondary species of significance.

4.2 Terrestrial Effects Studies

The objective of air monitoring in relation to terrestrial impact assessment is to provide exposure data which assist in:

- development of dose:response relationships required for setting air and soil standards, and

- diagnosis of acute and chronic terrestrial impacts.

In some cases, the MOEE undertakes the soil and/or vegetation assessment first, then interpolates the information to determine the need and best location for future air monitoring sites.

The inter-relationship between air and terrestrial monitoring is most convincing in cases where enforcement is required. In those cases, the Ministry's position

is enhanced if adverse effects can be demonstrated in areas where air standards or Certificate of Approvals requirements are exceeded.

Some of the gaseous pollutants that have phytotoxic potential include: ozone, peroxyacetyl nitrate, nitrogen dioxide, hydrogen fluoride, sulphur dioxide and ammonia. At present, only sulphur dioxide, ozone and nitrogen oxides are routinely measured in Ontario. The others are assessed only occasionally, during spills or via mobile surveys. Even with the existing network, improvements could be made in re-locating some of the routine monitoring stations to more rural or forested sites.

One type of monitoring activity that has received decreasing emphasis lately is dustfall measurement. In relation to soil contamination, it is still a valid tool, as it provides a direct measure of the deposition to soil. Another approach would require better estimates of dry deposition of suspended particulates to soils and vegetation.

4.3 Public Information (AQI)

Present status:

The Air Quality Index (AQI) is a real-time public information system for air quality in 24 urban centres across Ontario.

The AQI is related to the concentrations of six traditional air contaminants adversely affecting human health and the environment. These pollutants are: carbon monoxide (CO), suspended particles (SP), total reduced sulphur compounds (TRS), nitrogen dioxide (NO_2), ozone (O_3), and sulphur dioxide (SO_2). An additional parameter is the Air Pollution Index (API), calculated from

a combination of SO_2 and SP. An AQI sub-index is calculated hourly for each pollutant. The sub-index increases as the air quality deteriorates and the highest sub-index becomes the AQI. If the index value reaches 50-99 (ie., 'poor' levels), air quality may adversely impact the most sensitive human or animal populations, or may damage vegetation, property, or aesthetic values. An AQI of 100 or greater (ie., 'very poor' levels) may cause adverse effects to the health of a large sector of the exposed population.

The AQI is released to the media eight times daily. If the AQI is 32 or higher (ie., the transition point from 'good' to 'moderate' air quality) then it is released every hour. Forecasts are also released four times daily, the forecast period covering the current day and the following day.

Linked to the AQI is the Air Quality Advisory, issued jointly by MOEE and Environment Canada. When ozone levels above 80 ppb are forecast to occur over large parts of the province, public advisories are issued on the afternoon of the day before an expected episode.

The AQI and the Air Quality Advisory allow the public to respond appropriately to pollutant levels. The Advisory, in addition, encourages people to contribute to pollution prevention "Spare the Air" by using public transit and car pools, and refraining from use of gas-powered motors and some solvents.

Future objectives:

To improve the AQI, it should be brought more in line with the latest information on health and ecosystem effects. This might also apply to parameters such as O_3, CO, and TRS. Sub-indices such as inhalable particulates (PM_{10}) also be added in the near future.

A longer term future objective may be inclusion of additive or synergistic indices for pollutants currently included, plus air toxics.

4.4 Compliance With Regulation (API/LIMA)

Present objectives:

API:

The Air Pollution Index (API) provides an episode warning and regulatory control mechanism for the protection of human health in 24 Ontario cities. It was implemented as part of Regulation 346. Its purpose is to control local emissions of sulphur dioxide (SO_2) and suspended particulates (SP). Under the regulation, the Minister of Environment and Energy may order any source not essential to public health or safety to curtail or cease its operation when the API reaches levels that are considered injurious to health.

The API is calculated every hour from a combination of each of the running 24-hour average concentration levels of SO_2 and SP. As the API increases, the corresponding categories change from 'acceptable', to 'advisory', 'first alert', 'second alert' and 'air pollution episode threshold' levels. Various possible control actions correspond to these categories. If the index reaches a value of 32 (ie. 'advisory' level) and adverse atmospheric conditions are forecast to persist for six hours, an air pollution advisory is issued. Owners of significant sources of pollution are advised to prepare for possible curtailment of operation. Control orders for industries within a city may first be issued when the API at any of the API monitoring sites in the city reaches the 'first alert' level (API = 50) and adverse meteorological conditions are forecast to persist for at least 6 hours. Further subsequent curtailment of operations is ordered when the API increases category and adverse meteorological conditions are forecast to persist for at least 6 more hours.

In recent years, as a result of industrial emissions controls, Ontario has not experienced a 'first alert' level for the API.

LIMA:

The Lambton Industry Meteorological Alert (LIMA) system is a site-specific alert and control system enacted as Regulation 350 under the Environmental Protection Act. LIMA is limited to a part of the county of Lambton including the city of Sarnia. Four SO_2 monitoring sites, three in Ontario and one in Michigan provide the data.

The Minister may declare an Alert when the 24-hour running average SO_2 concentration at any LIMA monitoring station reaches 0.07 ppm, and forecasts indicate a continuation for 6 hours or more of weather conducive to elevated SO_2. The objective of the alert is to prevent exceedance of the Ontario 24-hour SO_2 Ambient Air Quality Criterion of 0.10 ppm (275 ug/m^3). During an alert, sources capable of emitting 500 kg of SO_2 daily must limit these emissions so that the concentration at any point of impingement does not exceed 415 ug/m^3.

Future objectives:

No changes are foreseen regarding the Air Pollution Index.

4.5 Input to Ecosystem Health Assessment

Ecosystem health assessment is a relatively new environmental management approach and is therefore addressed here under 'future objectives'.

Future objectives:

Ecosystems are dynamic natural communities, consisting of a web of physical, chemical, geological, and climatic factors, interacting with each other and with living systems. The concept of "Ecosystem Health" is based on the recognition that man-induced stresses on ecosystems can cause such substantive shifts in the ecosystem balance that undesirable changes result. The concept of "Ecosystem Health" reflects the growing awareness that the traditional compartmentalization of environmental management and monitoring by air, water, soil, etc. fails to meet the need to ensure that we don't lose the overall war, while focussing our resources on one battle.

Atmospheric processes play a major role in ecosystem health. Pollutants emitted into the air or volatilized from water or land, can cycle into the atmosphere, causing large scale impacts on climate (global warming), atmospheric changes (stratospheric ozone depletion) or impact on ecosystems far from the point of emission.

To provide the information for effective environmental management, air monitoring networks should provide data which can measure effects of local and long-range pollution, and can establish cause-effect relationships for terrestrial, aquatic and climatic impacts. Determining an optimal air monitoring network would be easier if there was a clearer understanding of the cause-effect relationships amongst ecosystem components. To improve this understanding, monitoring of the air and other components must provide information on a variety of parameters including climate, air transport phenomena, and transformation of chemicals in the air. All these must be provided for greatly varying time scales and geographical areas. Finally, the monitoring of parameters in different environmental compartments must be

coordinated to allow development of environmental transport and fate models, and calibration on the behaviour and effect of parameters of concern which cause cross-media impacts in the ecosystem.

4.6 State of the Environment Report

"State of the Environment Reporting" (SOER) is designed to provide information on the trends in parts of the environment important to people. Reporting is an integral part of environmental decision-making, providing a benchmark for evaluating the impacts of our activities and for assessing the effectiveness of our environmental management programs.

Information developed for SOER should permit the analysis of:

- long-term trends,
- cause-effect linkages,
- key components of ecosystem health and cross-media phenomena, and
- integrated data sets, such as changing land use, populations and species diversity with different pollutant concentrations.

4.7 Client Needs

Some general future needs have been noted in foregoing sections. Additional needs will be addressed in the 'Gaps/Options' section.

Some specific suggestions for future monitoring are:

- **Metals**

  - Mercury speciation would be desirable.

  - Toxic trace metal content of urban dust on the surface of schoolyards, play areas, and nearby sidewalks would provide more definitive data for children's exposure assessment.

  - Manganese monitoring should continue because of potential buildup of manganese in air and soil since manganese has replaced lead as a gasoline additive.

- **PAHs**

  - Monitor for nitro-, halo- and thia-PAHs of significance in air.

- **Carbon monoxide impacts**

  - Underground car parks, large parking garages and roadside areas should be investigated to assess the impact of CO and other vehicle emissions on pedestrians.

5. AIR MONITORING PROGRAMS

5.1 Ambient Air Monitoring Network

There are 86 ambient monitoring stations consisting of 236 monitoring instruments to obtain the concentrations of traditional air pollutants (nitrogen oxides (NOx), sulphur dioxide (SO_2), carbon monoxide (CO), ozone (O_3). suspended particulates (SP) and total reduced sulphur (TRS). There are also 95 sites providing total suspended particulate (TSP) data, 173 dustfall sites, 74 fluoride sites and 24 sites measuring inhalable particulate (PM_{10}) data. The TSP and dustfall samples are analyzed for constitutents such as heavy metals. Volatile Organic Compounds (VOC) are monitored at 16 sites, polyaromatic hydrocarbons at 11 sites, and dioxins at 2 sites. In addition a network of deposition samplers is used to collect data for acidifying pollutants and toxic pollutants.

The continuous data are telemetered via telephone lines to a central computer for storage and processing. This allows for real-time provision of air quality information and immediate compliance action as well as avoiding costly manual interpretation of strip-charts. All other samples are analysed by the Laboratory Services Branch (LSB) or external private laboratories.

A comprehensive quality control program is in place to ensure that data are scientifically credible and defensible in litigations.

Data from complementary monitoring programs in Ontario are also available to the Ministry (e.g., Ontario Hydro, Lambton Industrial Society).

Meteorological data needed to interpret air quality data are obtained primarily from a satelite link to real time weather information from Environment Canada. Supplementary data are obtained from the Ontario meteorological network of 34 sites.

The Atmospheric Studies Section of the Science and Technology Branch (STB) provides central coordination for a variety of special monitoring needs. For example, the Great Lakes Toxics Deposition monitoring program samples for persistent organic pollutants as part of the Great Lakes Water Quality and Canada-Ontario Agreements. Regional requests have resulted in the development of methodologies for sampling volatile organic compounds such as benzene and 1,3-butadiene (15 sites) and polycyclic aromatic hydrocarbons such as benzo[a]pyrene (11 sites). Work sponsored by the Council of Canadian Ministers of the Environment resulted in a reference method for sampling and analysis of dioxins and furans. Monitoring for these pollutants is done on a special request basis (e.g., the Toronto Waterfront Remedial Action Plan) or semi- permanently (e.g., in Windsor due to the presence of a 3000 ton-per-day incinerator in Detroit).

The above activities involve developmental work and are of a non-routine (both sampling and analysis) nature, especially at the inception stage. The STB also coordinates acid deposition monitoring meeting the needs of the Countdown Acid Rain program and the Canada-U.S. Air Quality Accord.

The regional Atmospheric and Terrestrial Effects Units are responsible for the day-to-day operation and maintenance of the air monitoring analyzers. The use of zero and span gases as well as portable calibration equipment to evaluate the instrument performance is part of the regional quality control program. The

portable calibrators are regularly checked by the Instrumentation and Quality Assurance Unit.

The Environmental Monitoring and Reporting Branch (EMRB) maintains a laboratory with gas standards referenced to those at the U.S. National Institute of Standards and Technology and the Pollution Measurement Division of Environment Canada. Performance audits are conducted on most of the continuous monitors every sixteen weeks.

A comparison of the Ministry's air monitoring program with similar programs in other jurisdictions of comparable size and population, shown in Figure 1 suggests that the Ministry's air monitoring program needs enhancement for ground level ozone and PM_{10} in order to properly define population exposure to the air pollutants.

5.2 Regional Special Monitoring and Emergency Response

Because of the non-routine nature of much of the special monitoring and emergency response performed by the Regional technicians this workload fluctuates from year to year. The workload is a direct function of the Ministry District Offices' response to public complaints, special information needs, and the number of accidental pollutant releases into the environment.

5.3 Stack Sampling

Stack sampling is carried out as a requirement of Certificates of Approvals and for other needs. Sampling is done to confirm whether emission limits are being exceeded by companies suspected of polluting. Stack sampling data have also been used to develop standards and confirm emissions inventory data.

5.4 TAGA Program

The TAGA (Trace Atmospheric Gas Analyzer) is a state-of-the-art mobile laboratory capable of on-site testing of air to determine the concentration of toxic chemicals. The technology used is mass spectrometry (MS). In January, 1979, the potential of this mobile system was immediately realized when the TAGA was used to track toxic chlorine gas plumes following the Mississauga train derailment. The utility of the TAGA was proven again in 1982 at the Medonte train derailment where hydrofluoric acid fumes were released. In 1986, TAGA monitoring in Cornwall revealed exceedance of the Ministry standard for chlorine, resulting in a conviction. In 1988 the TAGA responded to a PCB warehouse fire in the Quebec community of St. Basile Le Grande. Following this emergency the Quebec Environment Ministry purchased its own TAGA. In 1990, the TAGA 3000 was retired and replaced with a TAGA 6000 using an emerging technology: tandem mass spectrometry. The TAGA 6000 has the ability to analyze complex mixtures of unknown chemicals, a feature utilized at the 1990 Hagersville tire fire. To handle the growing number of survey requests, a second TAGA 6000 unit was commissioned in 1992.

TAGA vs the Fixed Air Monitoring Network

The stationary air quality monitoring network measures several air pollutants continuously. For source-specific studies near some industries, the TAGA fills a role not provided by stationary monitoring sites. The TAGA's mobility and capability for measurement of non-traditional pollutants allows for temporary set up at any location, making it ideal for monitoring individual sources. Additionally, the TAGA provides pollution "contours" by moving around a suspected source.

Monitoring Capabilities

The types of chemicals typically monitored by the TAGA 6000 are listed in Tables 3 and 4. A third monitoring mode, LCMS (Liquid Chromatography Mass Spectrometry), is under development and will provide on-site analysis of semi-volatile compounds such as PAHs (PolyAromatic Hydrocarbons).

Although primarily devoted to mass spectrometric analysis of air, the TAGA unit has capacity for other air analyzers. For example, the TAGA group has developed a mercury vapour monitor, which has been used to identify mercury emissions from incinerators. There are also plans for inclusion of a TRS (Total Reduced Sulphur) analyzer in the TAGA unit to monitor noxious sulphur odours.

Applications and Clients

The majority of the requests for TAGA surveys come from MOEE regions, especially in situations where residential areas abut industry. Other clients including Approvals Branch, Investigation and Enforcement Branch, Legal Services Branch and Standards Development Branch, use TAGA data for environmental appovals, enforcement, and standards development purposes. The TAGA is continuously on standby to respond to chemical spill emergencies.

Table 3: Industries and Types of Compounds Detected by the TAGA in APCI Mode

INDUSTRIAL SOURCE	CHEMICAL POLLUTANTS
Painting operations	**Ketones** (e.g., Methyl isobutyl ketone) **Esters** (e.g., Ethyl acetate) **Alcohols** (e.g., Ethylene glycol)
Foundries	**Phenols** **Cresols** **Acid vapour** (e.g., Hydrofluoric acid, Hydrochloric acid)
Pulp and Paper Mills	**Sulphur compounds** (e.g., Dimethyl disulphide)
Steel Mills	**Aromatics** (e.g., naphthalene)
Plastic Manufacturers	**Amines** (e.g., trimethyl amine, nitrosodimethyl amine)

Table 4: Industries and Types of Compounds Detected by the TAGA in GCCI Mode

INDUSTRIAL SOURCE	CHEMICAL POLLUTANTS
Municipal Landfill Sites	**Landfill gases** (e.g., vinyl chloride)
Petrochemical Industry	**Monomers** (e.g., butadiene styrene)
Urban Environments	**Auto exhaust** (e.g., benzene, toluene, xylenes)
Dry Cleaning Industries	**Chlorinated compounds** (e.g, perchloroethylene)
Waste Incinerators	**Incineration by-products** (e.g., chlorobenzene)
Industrial Painting Operations	**Solvents** (e.g., dichloromethane, trichloroethane butyl benzene)

6. TRENDS IN AIR QUALITY DATA

6.1 Documenting Abatement Success

There are many examples in Ontario where trends in air quality have confirmed the success of Ministry abatement programs. Examples included here represent a range of pollution sources in various regions.

6.1.1 Steel mills, Hamilton

Figure 2 shows the correlation between particulate matter emissions from steel mills and Hamilton air quality. The graph clearly shows a steady decline in emissions from the early 1970s to the present. The resulting benefits are revealed in the trend of improvement in dustfall and TSP (total suspended particulate matter).

6.2.2 Metals plant, Toronto

Airborne lead declined sharply near Canada Metals Co. after emissions were reduced under Control Orders issued in 1973, 1976 and 1979, as shown in Figure 3. Air quality trends expressed as the annual mean airborne lead concentration and the number of exceedances of the 24-hour lead criterion, mirrored this abatement success.

6.2.3 Nickel smelters, Sudbury

As indicated in Figure 4, there has been a marked decrease in "potentially injurious fumigations" (PIFs) of sulphur dioxide (SO_2) in Sudbury over the past 30 years. PIFs may cause vegetation damage. The PIF decline is attributed

to reduced ground-level SO_2 resulting from a new tall stack in 1972, shutdown of one of the smelters, improved smelter process technology, Ministry Control Orders and the Countdown Acid Rain Program.

6.2.4 Pulp mill, Dryden

Modernization of the Avenor Inc. kraft pulp mill in the early 1980s resulted in much reduced emissions of TRS (total reduced sulphur). The data in Figure 5 document the benefit of this effort, as exceedances of the TRS interim standard declined to negligible levels.

6.2.5 Pulp mill, Fort Frances

Fallout of "saltcake" (sodium sulphate) near the Boise Cascade Canada kraft pulp mill was the cause of many complaints from area residents. Improved process controls have reduced saltcake emissions, as confirmed by declining levels of sodium in leaves of Manitoba maple trees (Figure 6). Fallout complaints no longer occur.

6.2.6 Ore concentrate transfer site, Schreiber

There were numerous off-property dust complaints following the start-up of a transfer site for zinc and copper concentrates. A new concentrate transport system introduced in 1992 resulted in greatly reduced dust emissions. Snow sampling surveys in 1991 and 1993 (Figure 7) documented the "before" and "after" situation. There have been no dust complaints in the past two years.

7. AIR QUALITY COMPUTER MODELS

7.1 Introduction

For much of their history, mathematical models of the transport and fate of pollutants in the atmosphere existed somewhat separately from measurements. However, it is clear that a close integration of the two activities will strengthen both.

In essence, a mathematical model provides a framework which describes and incorporates our scientific understanding of the chemical and physical behaviour of the constituents of the atmosphere. Comparison of model predictions with measured data allows an assessment of the validity of this understanding. Discrepancies are a signal that the understanding is incorrect, or incomplete, thus pointing to areas for further research. On the other hand, a model can indicate areas of improvement for a monitoring program, e.g., by pointing out the optimum geographic locations for monitoring sites.

The ultimate objective will generally be to apply models in the development of abatement strategies. This involves using the models to assess the effects of changing the emissions from individual sources or groups of sources.

7.2 Types of Models

A wide range of atmospheric models is currently available. The type of model to be applied to a given situation will be determined by the space and time scales involved, and by the pollutant species of concern. Broadly speaking, the models may be considered as belonging to one of the following categories:

- *Small Scale Models.* These are applied to individual sources or groups of sources, and consider their impact at distances of up to a few kilometres or tens of kilometres. At these distances the concentration of the pollutant of concern is essentially determined by dilution, as it is mixed into the atmosphere, and chemical transformation can almost always be ignored. Small scale models are available to predict impacts on time scales ranging from less than an hour to a year or longer.

- *Mesoscale to Regional and Long Range Scale Models.* These models treat spatial scales ranging from hundreds to thousands of kilometres, and time scales from hours to years. This class of models may be further subdivided into:

    - Lagrangian models, which describe the transport of individual air parcels, and which are therefore best applied in assessing the impact of individual sources or groups of sources, or the impact on individual receptors or groups of receptors.

    - Eulerian models, which describe the movement and behaviour of pollutants over a defined grid. These models are more computationally demanding than Lagrangian models, but are more useful in assessing impacts of sources over a wide area, or impacts on broad spatial scales.

On these scales it is necessary to treat all of the processes which act on pollutants in the atmosphere, including transport, mixing, chemical and physical transformation, and deposition to the earth's surface.

7.3 Application of Models

Network Design

In establishing monitoring networks, especially on a regional scale, it is usually important to make measurements in the areas of maximum impact, and also in those areas where the concentration gradients are the highest, since this allows the most accurate definition of the spatial patterns of pollutant concentration. In the absence of historical measurements, the only way to define these locations is to predict the concentrations using a model. A monitoring network should also capture future shifts in the position of maximum impact, arising, for example, from changes in emission patterns. Modelling is the only tool available to predict the effect of future changes.

Similar considerations apply in the redesign or optimisation of an existing network, though model predictions in this case will be supported by the data set collected in the existing network.

Spatial Interpolation

Measurements are necessarily made at discrete points in space, and can therefore not capture all of the spatial variability of pollutant concentrations. Statistical methods exist for interpolating between discrete measurements, but they can not enhance the information content of the existing data. For example, if a localised hot spot of concentration exists between monitoring sites, the measurements have no knowledge of it, so that interpolation techniques cannot find it. However, a mathematical model can locate such a hot spot, because it makes use of information on all of the atmospheric processes that cause the hot spot to occur.

Mass Balance Studies

An example of a mass balance study is the assessment of pollutant transport into and out of a given area. This type of assessment is difficult, or impossible, to carry out based on an analysis of monitoring data alone, since it requires an integration of emissions information, knowledge of dispersion, transformation and deposition, and measured concentrations. This integration actually comprises an atmospheric model.

Improved Scientific Understanding of Atmospheric Processes

Since mathematical models are based on a mathematical description of current understanding of atmospheric processes, a test of model results constitutes a test of this understanding. Inadequacies in model predictions point to areas of incomplete or incorrect understanding, which can then be addressed by way of focused research programs. In this way models and measurement data are integrated in a process of continued scientific improvement.

In addition, models allow assessment of the effects of changes in emissions, whether from single sources, groups of sources or across a wide spatial region. The corresponding information is effectively impossible to obtain experimentally, because of the prohibitive cost of shutting down, or modifying, the corresponding sources while concentration measurements are made. This type of experiment is the basis for the development of abatement strategies.

8. EMISSION INVENTORIES

8.1 Introduction

Data on discharges into air, water and soil media are necessary inputs to all aspects of environmental planning. Air emission data from stationary point sources, mobile sources and area sources are collected by the Air Quality and Meteorology (AQM) Section of EMRB.

Usually, emission inventories are estimated from engineering and process information provided by the industries. At present, there is no legislated reporting requirement for air emission data. Actual measurement of the species at their points of release is very expensive. Furthermore, for some species such as nitrogen oxides and especially VOCs, there is a large contribution from natural sources. The quantity of natural emissions can be estimated using meteorology and modelling analyses, combined with air quality data. Discharges to water are somewhat simpler to obtain through measurements. This is also true for waste data, although the chemical species in the wastes are not fully categorized at present. Data for water and wastes are collected by the Environmental Information and Systems Section of EMRB.

Air emissions are estimated in co-operative agreements with Environment Canada and U.S. EPA. The data are entered into local data bases for use by the Ministry.

8.2 Client Needs

Emission data are needed for:

- Standard setting (e.g., PM_{10})
- Regulation and Policy Development (e.g., NOx/VOC Management Plan)
- Environmental Impact Assessment (e.g., Windsor '91 Toxics Study)
- Source - Receptor Analysis (e.g., INCO- Sudbury Emission Model)
- Emission Reduction Program Assessment (e.g., Countdown Acid Rain Program)

Comprehensive, credible environmental assessments require the analysis and reconciliation of source emission information with ambient air monitoring data.

8.3 Air Emissions Databases

Air emission estimates for SO_x, NO_x, CO, particulates and VOC's exist for the years 1980 to 1992. In addition, there is a 1985 toxics inventory for selected polycyclic aromatic hydrocarbon (PAH), polychlorinated biphenyls (PCB), dibenzo-p-dioxins (PCDD) and dibenzofurans (PCDF) and approximately 30 selected organic pesticides. Emission inventories are also compiled for special studies such as the Windsor Air Quality Study, greenhouse gases, and acid gases for the eastern part of North America.

Ontario's emissions inventory is based on information obtained from: voluntary industrial emission surveys; provincial statistics; Statistics Canada; and special study reports.

The quality of these emission estimates was maintained with the adoption of recognized methodologies prepared by different emission-compiling agencies. These methodologies include: the U.S.EPA AP-42 Pollutant Emission Estimation Manual; Environment Canada's Method Manual in Estimating Pollutant Emissions; MOEE's Certificate of Approval Records; source-specific emission profiles; and other recognized study reports from various industrial associations.

In the case of natural emissions, estimates often require the use of meteorological and other data, and appropriate models.

8.4 National Pollutant Release Inventory (NPRI)

This program was initiated by Environment Canada in 1993 under the authority of Canadian Environmental Protection Act (CEPA), subsection 16(1). A facility must report on one or more of the 178 substances shown on the 1993 NPRI substance list, if the facility has ten or more full-time employees and has manufactured, processed, or otherwise used 10 tonnes or more of any one of the listed substances with a concentration greater than or equal to 1% by weight. The first NPRI report is planned for release by the end of 1994. Currently, MOEE is negotiating with Environment Canada for closer co-operation in this undertaking.

Since Ontario has no legislated authority to obtain emission data, it is prudent to use the NPRI to obtain as much data as possible from emitters in a "one-window" approach. Such co-operation will avoid duplication of effort at both agencies in compiling data on multimedia pollutant release. Discussion is underway between both agencies to develop additional federal-provincial co-operative environmental reporting programs, using NPRI as the foundation.

9. REPORTING AND USE OF DATA

9.1 Reports

Ambient air data from continuous monitors provide hourly averages. These averages are the basis for the Air Quality Index issued to the public. A monthly summary of the hourly data is produced which also includes statistical information on minima, maxima and means.

The annual Ontario Air Quality Report is produced by the Air Quality and Meteorology Section of EMRB (final draft within seven months of year end). This report summarizes data from the Ontario air quality and meteorology monitoring program. The report also includes discussion about selected air toxics (VOCs and PAHs) monitored by the STB and Environment Canada, as well as case studies of air quality in selected neighbourhoods, cities and regions. A comparison is also included in which selected cities in Ontario are compared to other cities around the world.

Other reports of special interest which are related to the air monitoring program include the annual audit report for the gaseous pollutants of the ambient air monitoring network, the fast reference emission document for Ontario, the state of the environment report, reports on acid deposition and air toxics.

9.2 Data Base

The ambient air quality data after quality control are stored in the Air Quality Information System (AQUIS). Currently, AQUIS contains about 30 years and 1000 million bytes of information. Approximately 4 million air pollution

measurements are added to AQUIS every year with most representing the more heavily populated urban areas within Ontario.

AQUIS data comprise hourly, daily, and monthly measurements. In all cases, a valid annual mean requires at least 67% valid data.

Separate data bases are maintained for PAHs, VOCs, acid and toxics deposition.

Meteorological data are archived and stored in MDAS (Meteorological Data Acquisition System). MDAS contains 14 years and 2500 million bytes (compressed) of information.

9.3 Quality Assurance/Quality Control

The use of data of poor quality can lead to incorrect decisions concerning environmental standards and regulatory action. Therefore, collecting good data through a quality assurance program makes sound technical and economic sense. Quality control is the system of internal activities sustaining a high quality product. Quality control of the air quality monitoring program is implemented by the staff of the Operations Division.

Quality assurance is external action ensuring that a product satisfies given needs. One of the primary quality assurance tools is a performance audit performed by a person other than the regular operator, with standards and audit equipment physically different from the operator's equipment. Audit and calibration services are provided by the Instrumentation and Quality Assurance Unit of the Air Quality and Meteorology Section of EMRB. This unit operates under a division (ESSD) separate from the Operations Division, which is

responsible for monitoring operations. This separation provides independence of policy and practice such that the Instrumentation and Quality Assurance Unit can properly perform audits within the Ministry, and externally with respect to other organizations which conduct air monitoring programs.

9.4 Air Quality Assessment

Air quality data are used in numerous studies which analyze the effects of the air quality at neighbourhood, city-wide and regional scales. The data are analyzed for spatial and temporal trends for the province as a whole and at various subregions of the province by integrating meteorological, emission and air quality data. The results of these analyses are used for source-receptor analyses, compliance and investigation, assessing the effectiveness of pollution reduction and abatement activities, identifying areas of non-attainment and reporting on the state of the air quality in the province.

Air quality data and emission inventory information are needed to understand source-receptor relationships. The emission rates into the air are estimated from information obtained from relevant sources. Data on point, area and mobile sources are estimated for the criteria pollutants and are stored on OEIS (Ontario Emission Inventory System).

Assessments are also conducted by integrating air quality and phytotoxicological data as well as deposition data and Great Lakes water quality data.

9.5 Model Validation

Because of the limited number of monitoring sites, dispersion models are used to assess the impact of emissions on air quality. Since these models attempt

to simulate complex conditions, they require validation against ground-level ambient data.

9.6 Outside users

The air quality data are used by the federal government as part of their National Air Pollution Surveillance, as well as by other agencies such as the Lung Association and the World Health Organization. Academic researchers and private consultants require the air quality data for studying the effects of air pollution on health, property and vegetation. MOEE air quality data are also used in many interprovincial and Canada-U.S. transboundary environmental assessments, and in issues of continental and global concern (eg. NOx/VOC management, acid deposition).

10. COST OF OPERATION OF THE PROGRAM

The ODOE budget of EMRB for the Air Monitoring Program for Fiscal 1993-94 was $532 K. The total PYs for the program from EMR Branch is 17.

The ODOE budget of EMRB for the TAGA Program for Fiscal 1993-94 was $189 K. The total PYs for the program from EMR Branch is 5.

The ODOE budget of STB for the Air Toxics and Acid Rain Program for Fiscal 1993-94 was $130 K. The total PYs for the program from EMR Branch is 3.

The total ODOE of Operations Division is approximately $780 K and the PYs approximately 35.

The total ODOE for LSB analyses is $73 K and the PYs approximately 13.

The Air Monitoring Program is managed jointly by the Environmental Monitoring and Reporting Branch (EMRB), Science and Technology Branch (STB), and the Regional offices of the Operations Division, along with the National Air Pollution Surveillance (NAPS) of Environment Canada through the Air Quality Management Committee (AQMC).

AQMC reviews the program on a continuous basis for efficiency and effectiveness. For example, an extensive review was done in 1991 where a net reduction of 20% of the number of monitors was achieved. The savings were redirected to emerging issues such as air toxics and inhalable particulates. The telemetry costs have been reduced by ~80% and the telephone charges decreased by ~40%.

At the regional level, monitoring network reviews are also occurring. For example, the SO_2 monitoring network in the Sudbury area which has been reviewed and modified on a number of occasions since the 1970's in light of changing circumstances and identified needs, is currently under review.

11. PARTNERSHIPS

The MOEE is involved in partnerships with a variety of agencies. Environment Canada and the MOEE participate in the National Air Pollution Surveillance (NAPS) where many of the MOEE monitoring sites are also NAPS sites. Through the Atmospheric Environmental Service (AES) of Environment Canada, we have entered into cost sharing arrangements for ozone measurement. Partnerships exist with the Ontario Ministries of Labour and Transportation, in conducting radiation surveys around the nuclear plants and studies to determine effects on air quality due to highway expansion. The MOEE routinely uses data from SO_2 networks operated by Ontario Hydro around its thermal plants. Data from the LIMA network in Sarnia which has monitors operated by Ortech International for the Lambton Industrial Society, are sent to the MOEE South West Region office for evaluation.

A large network of sulphur dioxide monitors in the Nanticoke area is managed by the Nanticoke Environmental Committee including Imperial Oil, Stelco and Ontario Hydro and data from this network is available to MOEE.

In all these partnerships, performance of the monitors is routinely audited by the Instrumentation and Quality Assurance Unit of Air Quality and Meteorology Section of EMRB.

In addition, acid and toxic deposition monitoring is carried out in partnership with Environment Canada.

12. GAPS/OPTIONS

Based on the air monitoring program review, the committee has developed a list of gaps and needs for the Ministry with options for implementation as shown below:

Gaps and Needs

- EMRB should coordinate with Environment Canada and Operations Division the installation of ozone and low-level NO_x monitors along the shore lines of the lower Great Lakes.

- AQMC should accurately identify the impact of sources by integrating source data and ambient monitoring data.

- EMRB should develop a continuous PM_{10} monitoring program working in partnership with Environment Canada and Operations Division.

- ESSD should develop Data Quality Objectives (DQOs) and the need for PAH speciation in risk assessments.

- ESSD should develop air quality objectives and standards for additional pollutants and provide more timely reviews of current standards.

- ESSD should develop a risk assessment approach for non-threshold effect pollutants.

- EMRB should develop methods of better defining VOC levels and trends to ascertain progress in NO_x/VOC initiatives. Remote sensing monitors for VOC species could be developed working in partnership with Environment Canada, other Branches and Operations Division.

- ESSD should develop a monitoring program to capture VOC species for input to assessment of ground level ozone.

- EMRB should ensure the transfer of all ambient data from the monitoring network into a centralized data base.

- ESSD should develop, clear and enforceable regulations and monitoring methods to deal with public nuisance pollution, (e.g., black fallout, odours, chemicals).

- ESSD should develop sampling and analytical methods for additional compounds, especially the capability to identify odorous compounds and determine if there are more serious impacts for these compounds than odours.

A detailed tabulation of the GAPS, NEEDS and OPTIONS is provided in Appendix A.

OPTIONS

A. Continue to monitor for air pollutants with network optimization* and emphasizing the addition of PM_{10} (continuous), ozone along shorelines of the lower Great Lakes and low level NO_x monitoring in rural areas.

B. Continue to monitor for air pollutants as in Option A, including the use of remote sensing monitors. This option will require some additional resources. Explore partnership and RAC fundings.

C. Continue to monitor for air pollutants including remote sensing as in Option B, and develop additional enforceable regulations and monitoring methods for problem areas in Ontario as required.

---

* **The air monitoring network optimization is done continuously by the Air Quality Management Committee. For example, the network was downsized by approximately 20% in 1991 after a review. Figure 8 shows the trend in the size of the air monitoring network since 1971.**

RECOMMENDATIONS

1. Implement Option A immediately since it is resource neutral and it will improve monitoring efficiency in the areas of:

   (a) shoreline NO_x and O_3
   (b) continuous PM_{10}.

The following can also be undertaken under Option A:

   (a) examination of canister based monitoring tgechniques
   (b) studies on reconciliation of air emissions and ambient data
   (c) development of DQOs for organic monitoring
   (d) ensure the transfer of all ambient data from the monitoring network into a centralized database.

2. Implement Option B in partnership and coordination with other agencies as resources are made available.

3. Implement Option C in consultation and partnership with Program Development Branch, Standards Development Branch, Science and Technology Branch, Operations Division and Federal Agencies.

APPENDIX A

DETAILED TABULATION OF THE GAPS, NEEDS AND OPTIONS

GAPS AND NEEDS			
PROGRAM ELEMENTS	**GAPS**	**NEEDS**	**OPTIONS**
CONTINUOUS MONITORS	INADEQUATE SHORELINE COVERAGE OF O_3 AND NOx	2-3, O_3 MONITORS 2-3 LOW-LEVEL NO_x MONITORS	ENV. CANADA WILL BEAR COST OF MONITORS. NOMINAL COST ($5,000) TO MOEE FOR ACCESSING DATA.
	PM10 INHALABLE PARTICULATE	3 CONTINUOUS PM10 MONITORS IN MAJOR URBAN SITE	AQM SECTION WILL COVER COST REDIRECTING AQI/API TELEMETRY/ COMMUNICATION SAVINGS AND SAVINGS FROM AQI, TSP SITES OPTIMIZATION.
RATIONALIZATION OF AIR EMISSIONS DATA WITH AMBIENT AIR QUALITY MONITORING DATA	ASSESSMENT OF SOURCE RELEASES IN RELATION TO RECEPTOR AMBIENT AIR QUALITY DATA FOR NO_x/VOC MANAGEMENT STRATEGIES, AIR TOXICS AND PM10 PARTICULATES.	$50K/ANNUM TO INTERPRET SOURCE INFORMATION MEASUREMENTS, RECEPTOR AND DEPOSITION MODELS.	COST-SHARING, CO-OPERATIVE AGREEMENT WITH ENVIRONMENT CANADA TO PERFORM THE ANALYSES AS DONE IN THE WINDSOR '90 AIR QUALITY STUDY.

GAPS AND NEEDS (CONT'D..)			
PROGRAM ELEMENTS	GAPS	NEEDS	OPTIONS
PAH	ABSENCE OF WELL DEFINED DATA QUALITY OBJECTIVES AND SPECIES REQUIREMENT	DEFINE PROGRAM SPECIFIC DATA QUALITY OBJECTIVES AND SPECIES REQUIREMENT REDUCE COST	REVIEW PAH SPECIES ANALYTICAL NEEDS. - REDUCE SPECIES - DEFINE DATA QUALITY - BaP AS SURROGATE FOR PAH SPECIES.
1-3 BUTADIENE	LACK OF SUFFICIENT AMBIENT DATA FOR NO_x/VOC STRATEGIES AND AQ STANDARD SETTING. INCOMPATIBILITY WITH OTHER JURISDICTIONS. TARGET COMPOUND ANALYSIS OR INVESTIGATIVE ANALYSIS	MORE STUDY IS NEEDED	- LSB, STB TO REVIEW AND DEVELOP SAMPLING AND ANALYTICAL METHODOLOGIES. - COOPERATION WITH ENVIRONMENT CANADA. OPTION OR STATUS QUO.
CANISTER VOC SAMPLING AND ANALYSIS	MOEE SAMPLING DOES NOT PROVIDE ADEQUATE NUMBER OF SPECIES	NEED TO EXPAND ON THE SPECIES OF VOC MONITORED FOR THE NO_x/VOC AND AIR TOXICS PROGRAMS	- LSB, STB TO INVESTIGATE AND DEVELOP THE VOC-CANISTER TECHNIQUE. - LSB, STB, EMRB TO NEGOTIATE WITH ENV. CANADA FOR A CO-OPERATIVE MONITORING PROGRAM.

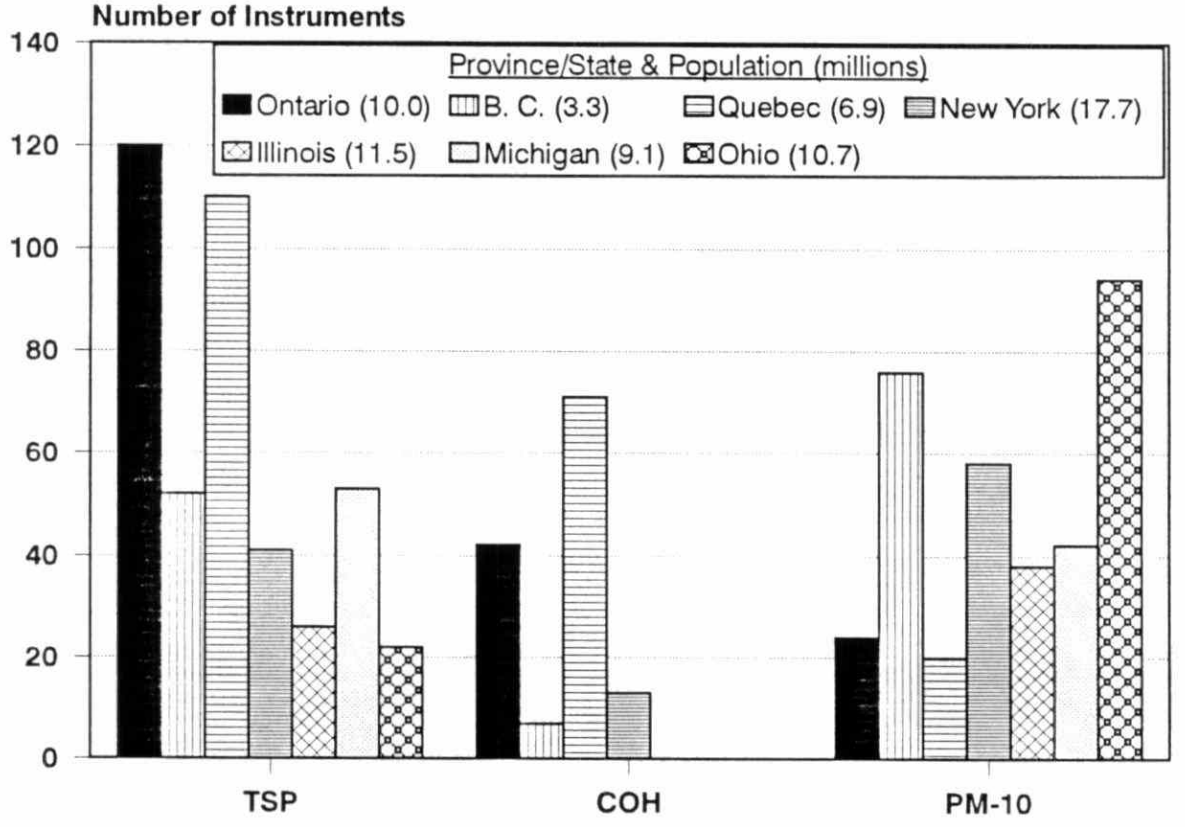
GAPS AND NEEDS (CONT'D..)			
PROGRAM ELEMENTS	GAPS	NEEDS	OPTIONS
REMOTE SENSING OF PHOTOCHEMICAL VOC'S/AIR TOXICS e.g., XYLENE, TOLUENE, BENZENE, ALDEHYDES	LACK OF HOURLY DATA FOR VOC'S OR AIR TOXICS TO SUPPORT NO_x/VOC STRATEGIES OR STANDARD SETTING PUBLIC INFORMATION	LONG PATH (1-2 KM) REMOTE SENSING CONTINUOUS MONITOR TO CHARACTERIZE THE SELECTED SPECIES	PROCUREMENT OF EQUIPMENT AND DEVELOP DATA BASE FOR VOCs AND AIR TOXICS SPECIES - $70K/YEAR FOR 3 YEARS - COST SHARING WITH ENV. CANADA - RAC FUNDING.

GAPS AND NEEDS (CONT'D..)			
PROGRAM ELEMENTS	GAPS	NEEDS	OPTIONS
ACID AEROSOLS, PARTICULATE ORGANICS, POLLENS	MOEE DOES NOT MONITOR ACID AEROSOLS, PARTICULATE ORGANIS, POLLENS	CO-ORDINATE WITH OTHER AGENCIES TO OBTAIN THESE DATA	- REGIONAL OPERATION, SDB, STB, EMRB AND DOE TO REVIEW AND UPDATE THE SPECIES, DATA QUALITY OBJECTIVE, METHODOLOGY AND PROGRAM PRIORITY. - ENSURE DATA COMPATIBILITY FOR USE BY RELATED MEDIA e.g., MULTIMEDIA MONITORING OF SELECTED SPECIES, SUCH AS Hg, ACID AEROSOLS, ODOUR, PAHs, C OF A., STACK SAMPLING AND MODEL DATA. - WORK WITH OTHER PARTNERS, e.g., ONTARIO HYDRO, LIS, ENVIRONMENT CANADA, W. GERMANY. - WORK WITH APPROVAL BRANCH.
STACK SAMPLING	STACK SAMPLING IS NOT IN PLACE IN ONTARIO. IT WILL BE EXPENSIVE FOR ALL SPECIES AND SOURCES.	RATIONALIZE SOURCE DATA BY COMPARING WITH AMBIENT DATA	
MODELLING ON PROVINCIAL SCALE TO INTERPRET DATA	DO NOT HAVE A MODEL AT A PROVINCIAL SCALE TO INTEGRATE AIR QUALITY DATA WITH SOURCE DATA	DEVELOP MODELS	

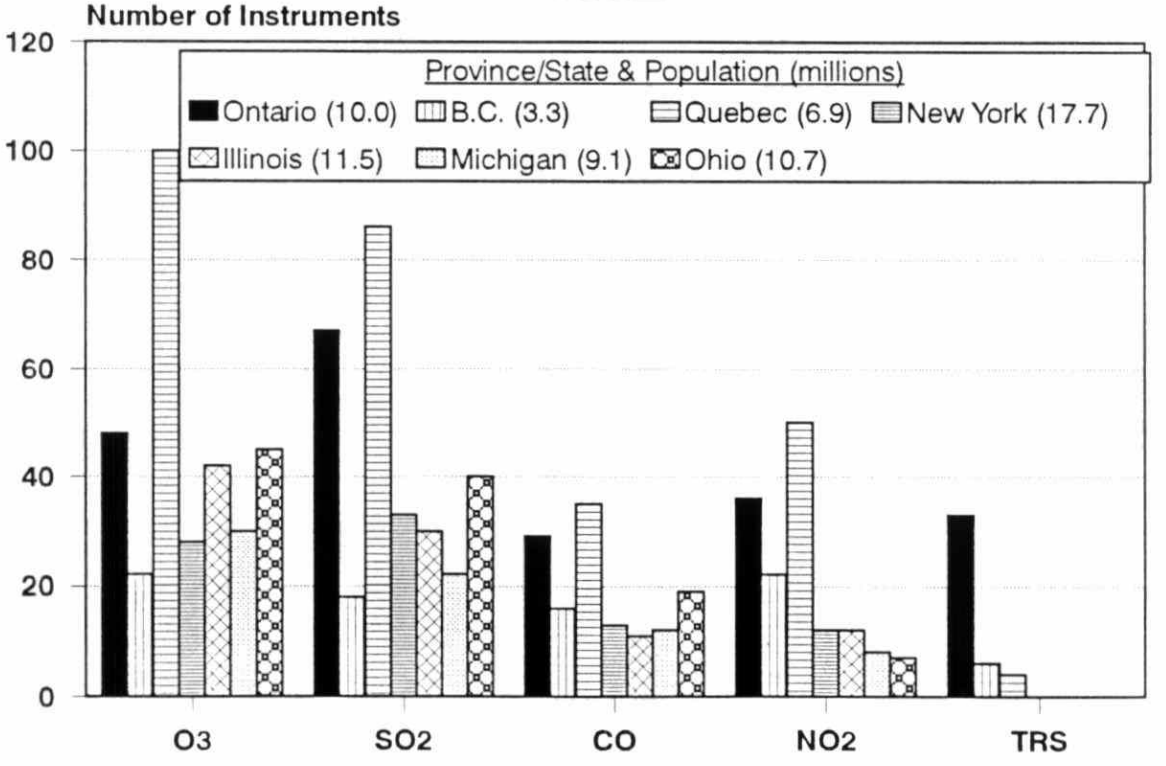
FIGURES

Figure 1

AIR SAMPLING NETWORK COMPARISON
Particulate (1992)



AIR SAMPLING NETWORK COMPARISON
1992



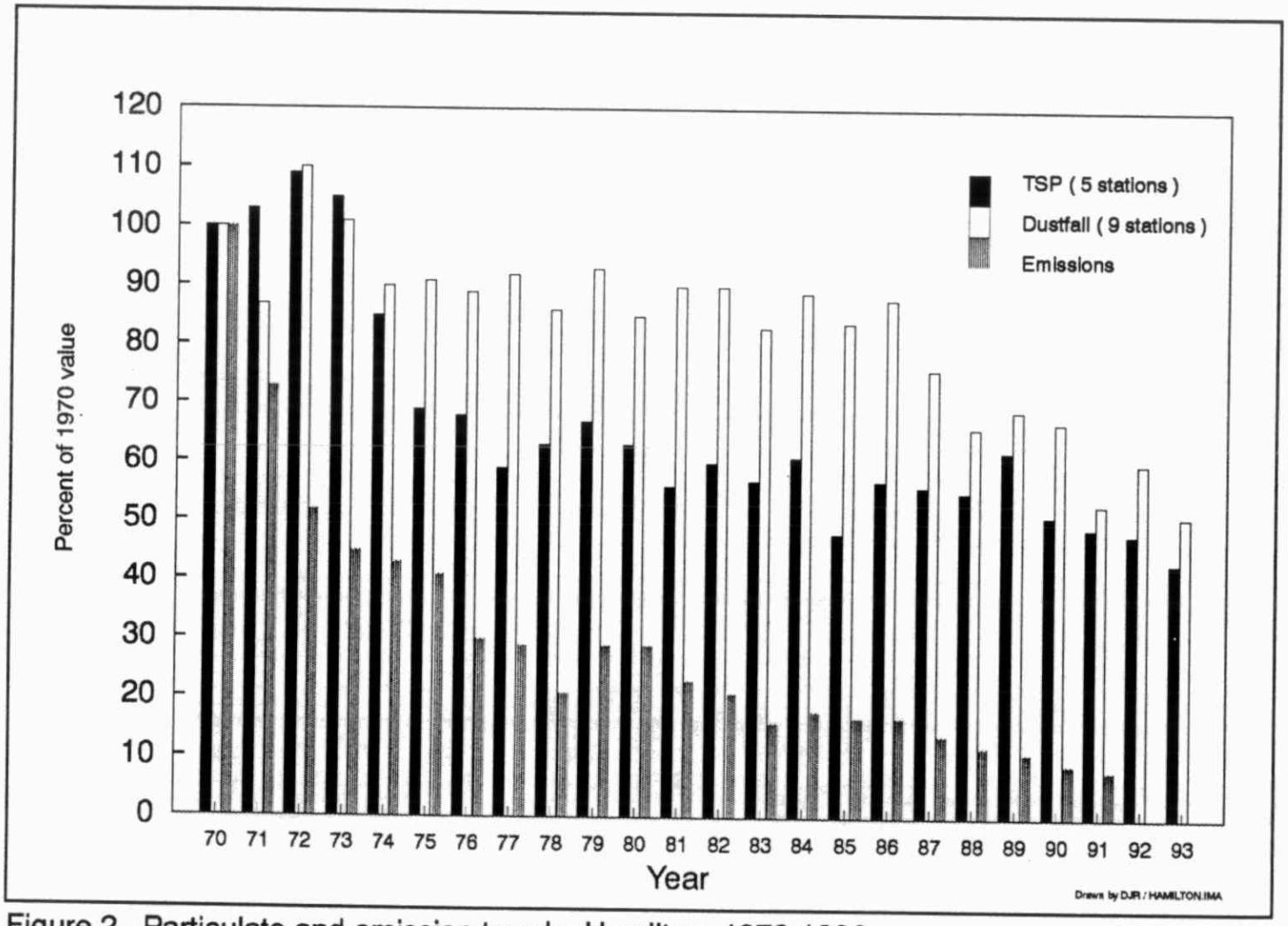


Figure 2. Particulate and emission trends, Hamilton, 1970-1993.

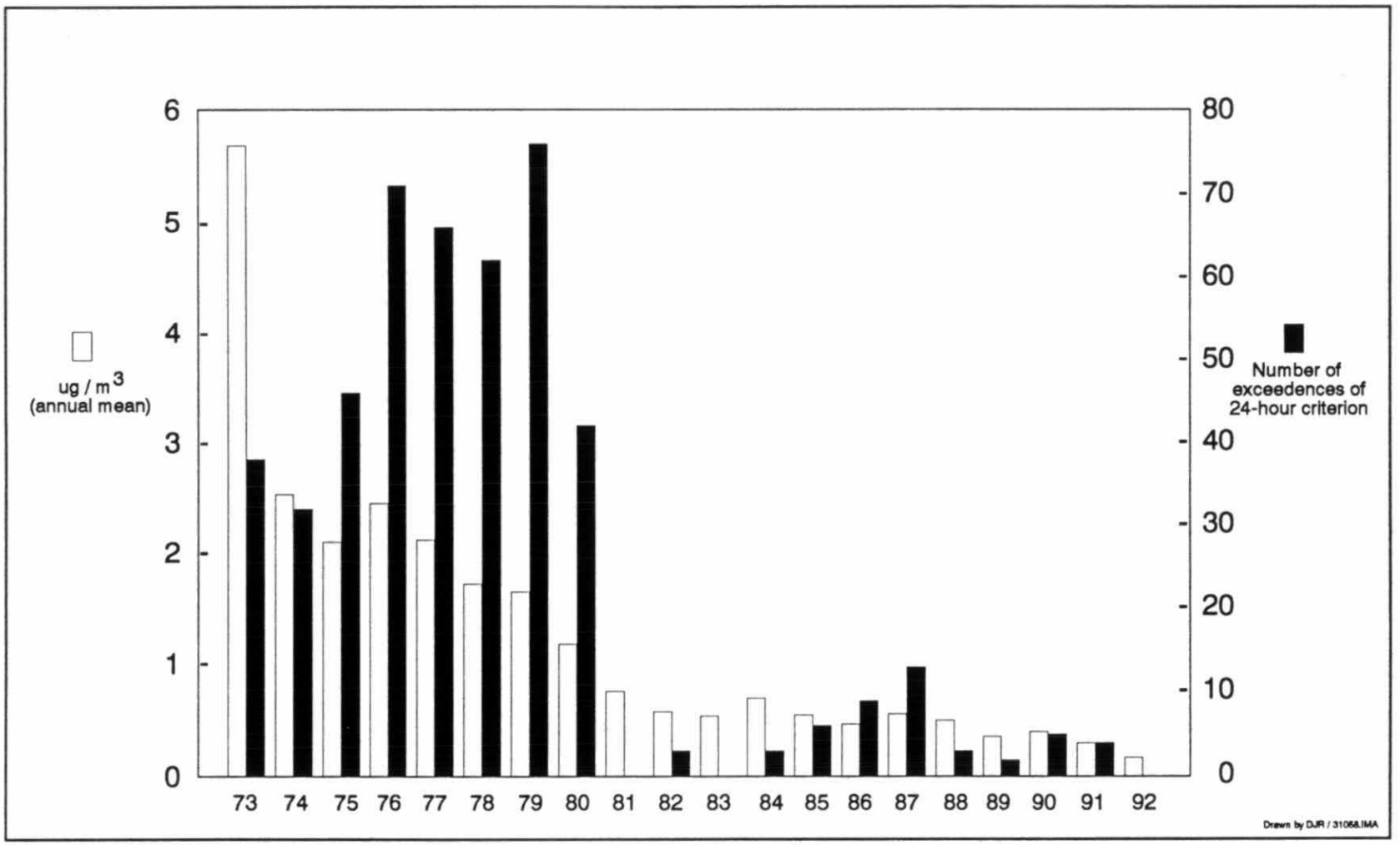


Figure 3. Lead in suspended particulate matter near Canada Metals Co., Toronto.

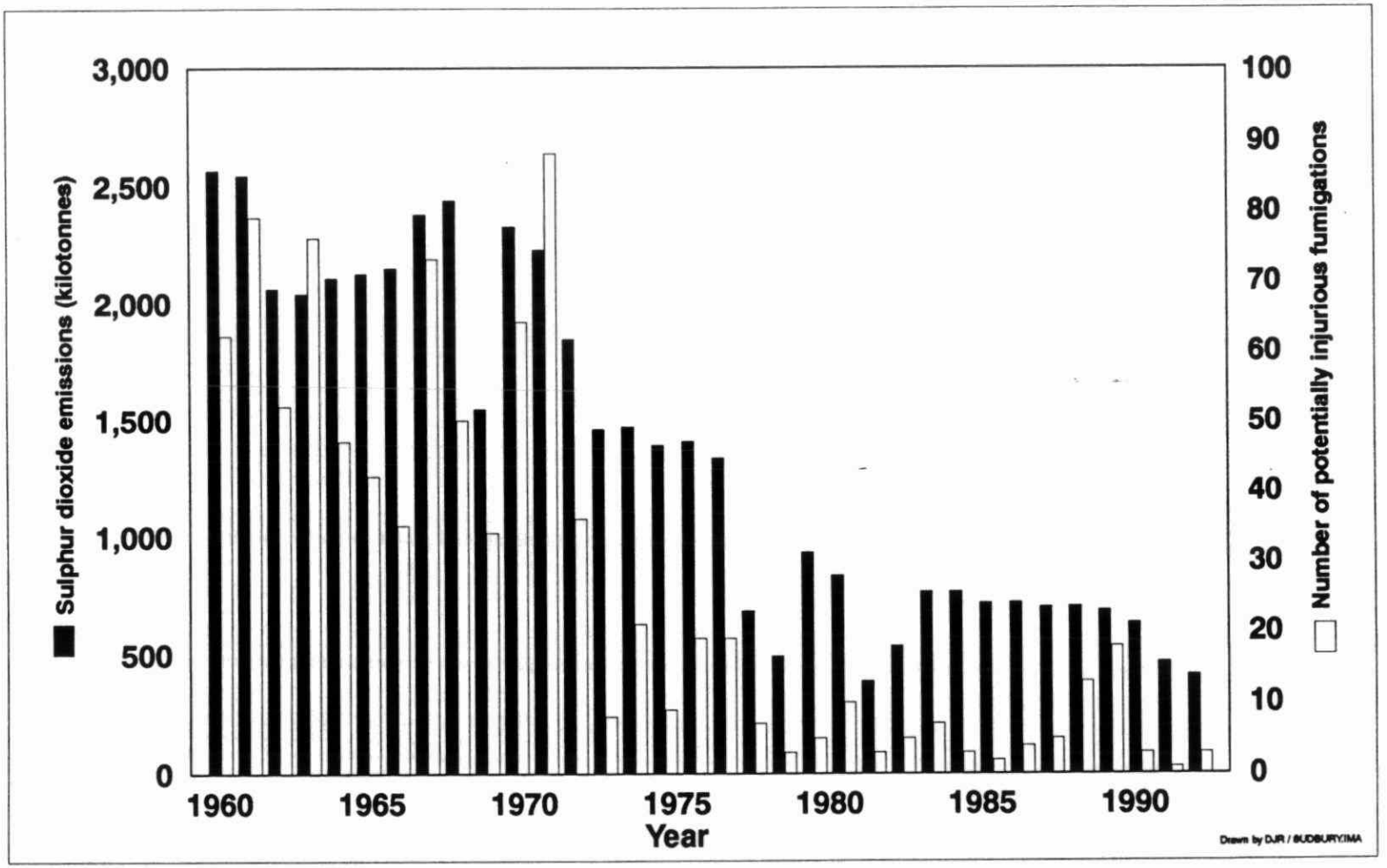


Figure 4. Total SO_2 emissions and number of potentially injurious SO_2 fumigations, Sudbury, 1960-1993.

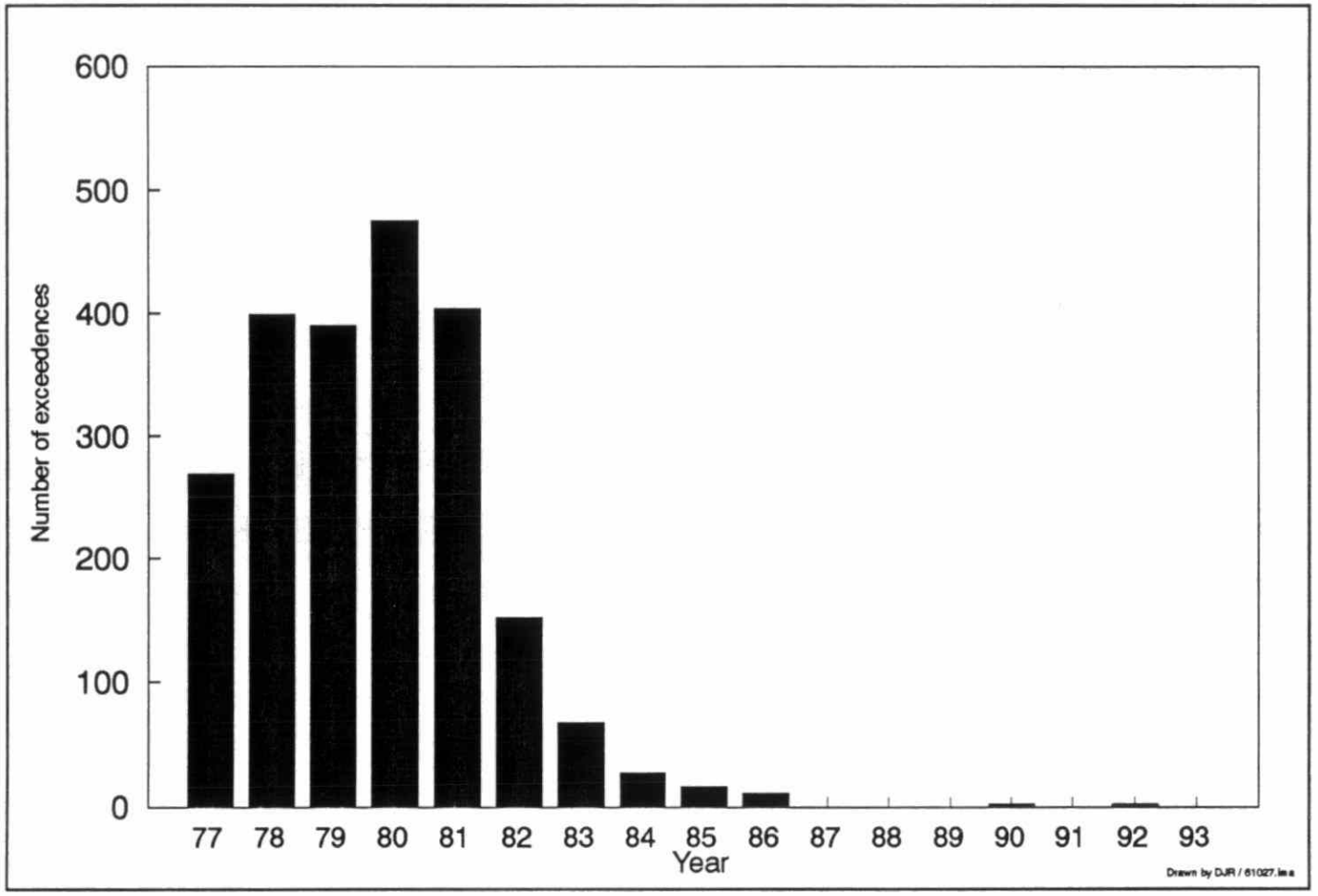


Figure 5. Exceedences of interim standard for total reduced sulphur, Dryden, 1977- 1993.

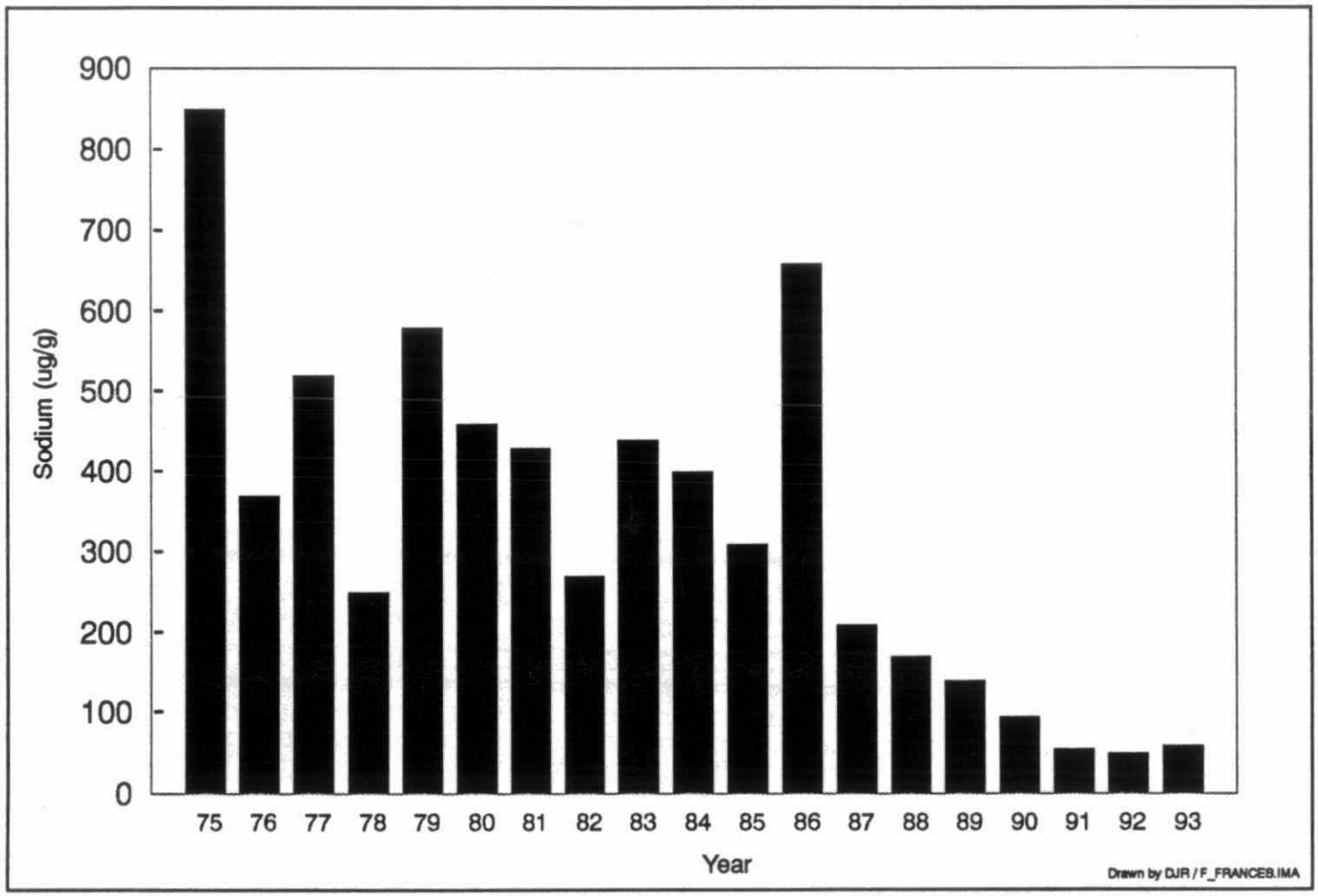


Figure 6. Average sodium in Manitoba maple foliage, Fort Frances-International Falls.

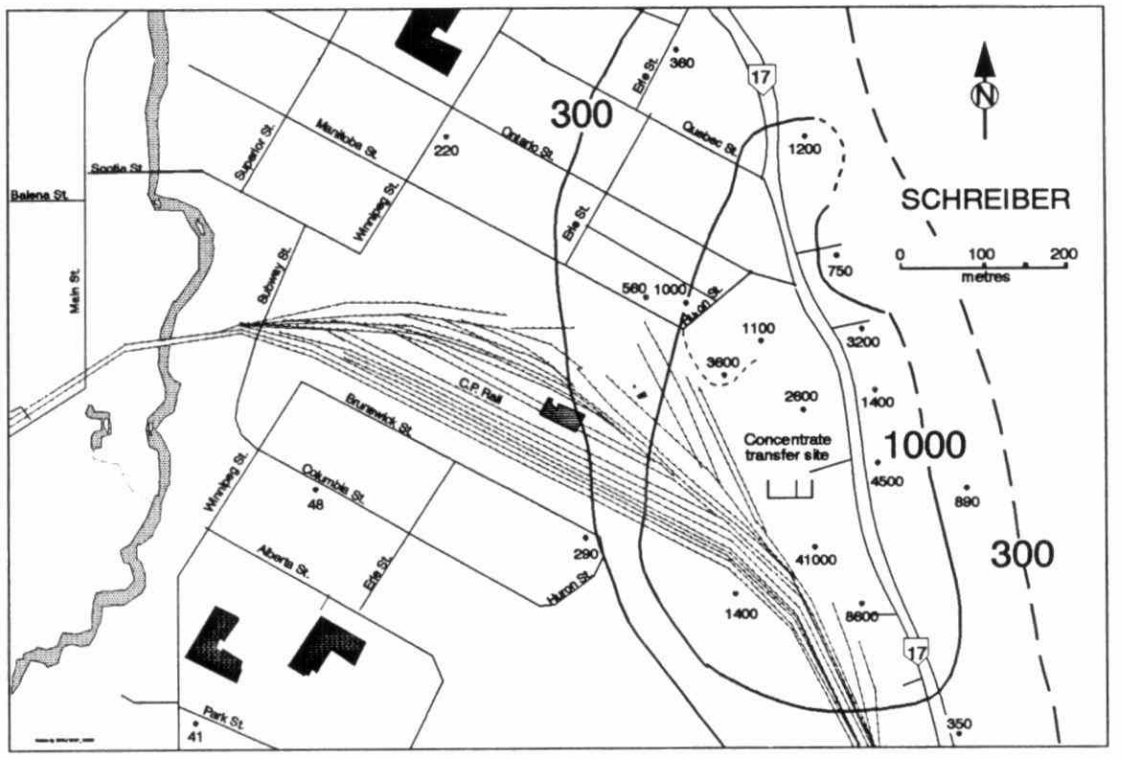


Figure 7a. Levels of zinc (ug/l) in snow meltwater, Schreiber, February 25-26, 1991.

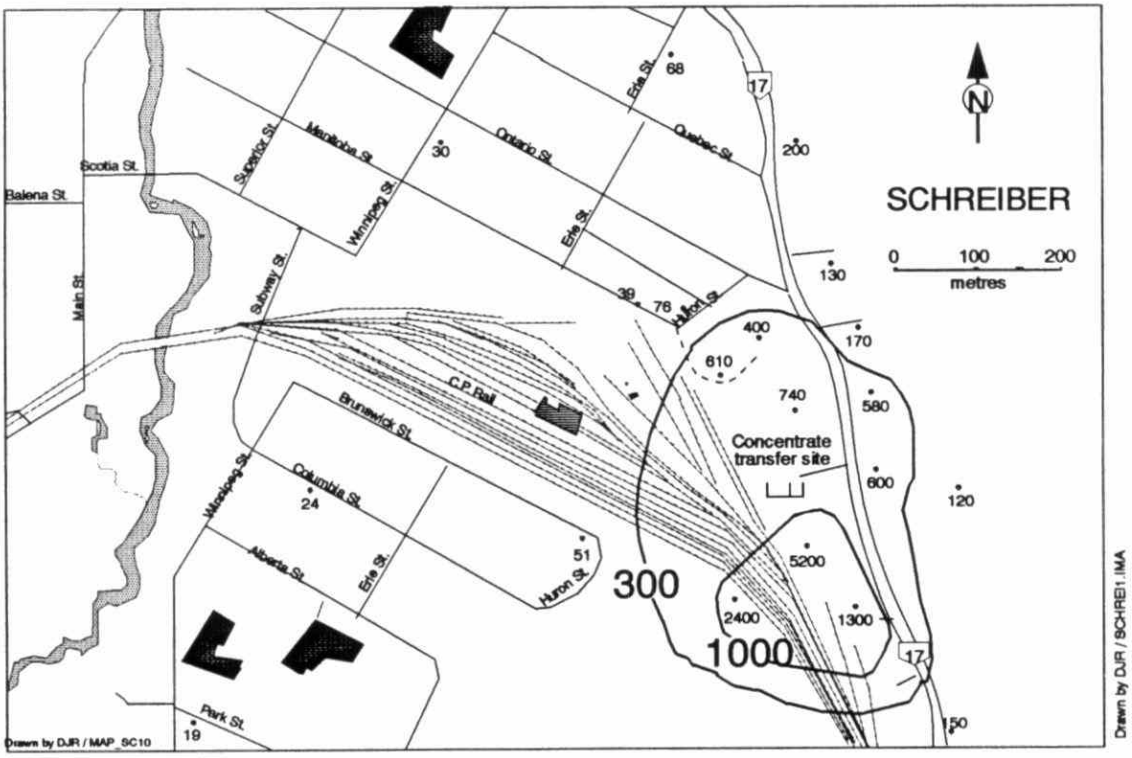
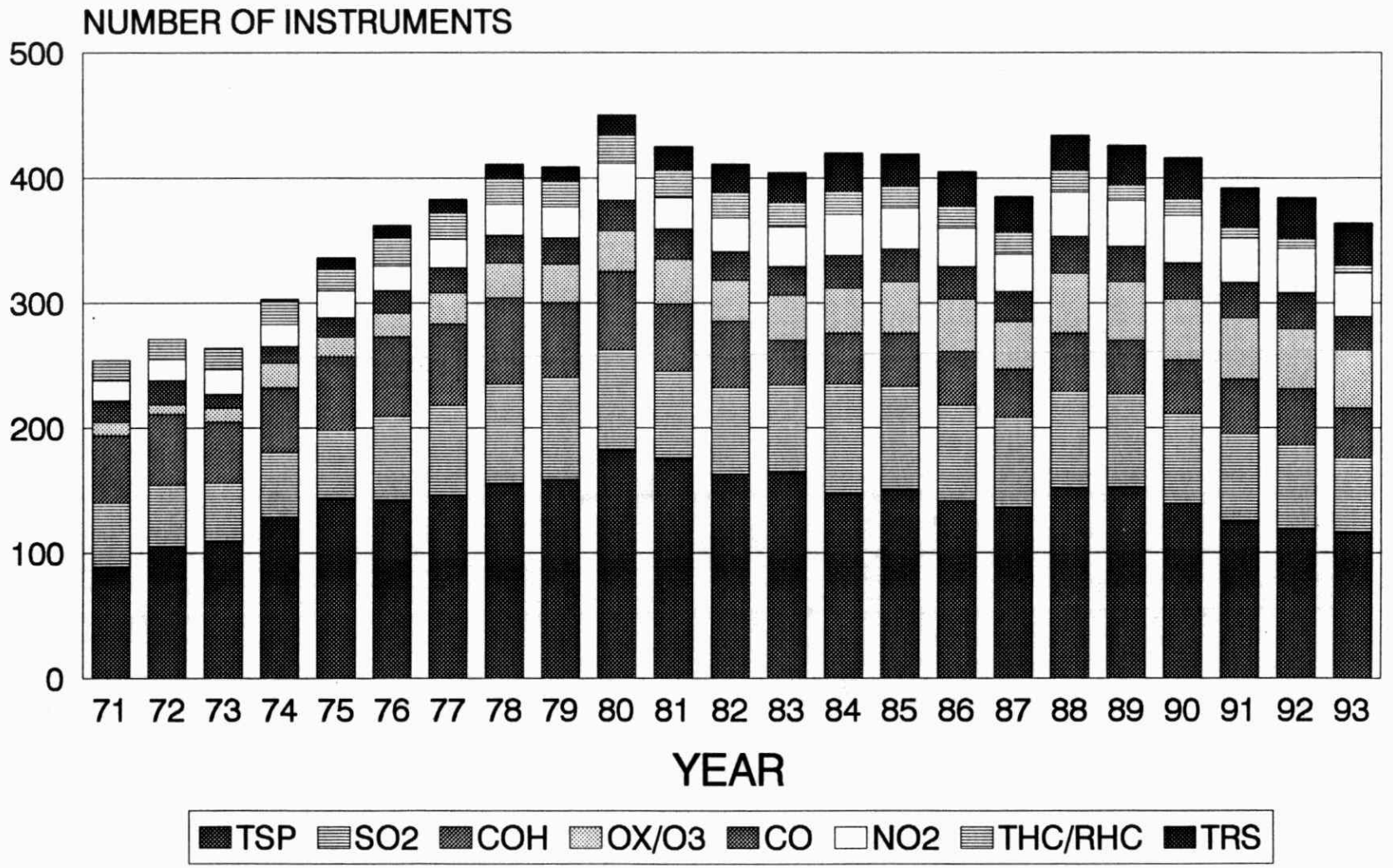


Figure 7b. Levels of zinc (ug/l) in snow meltwater, Schreiber, February 8, 1993.

FIGURE 8

ONTARIO AMBIENT AIR QUALITY MONITORING PROGRAM FROM 1971 TO 1993



Note: Does not include meteorological sensors and toxic organic chemical monitors

MONITORING REVIEW

SURFACE WATER

NOVEMBER 1994

REVIEW OF MINISTRY OF THE ENVIRONMENT AND ENERGY (MOEE) SURFACE WATER MONITORING PROGRAMS

PHASE 1
PROGRAM RATIONALIZATION AND OPERATIONS REVIEW

SURFACE WATER REVIEW COMMITTEE
ENVIRONMENTAL SCIENCES AND STANDARDS DIVISION (ESSD)
AND OPERATIONS DIVISION (OD)

NOVEMBER 24/94

- FOREWORD

The Interdivisional Surface Water Review Committee, as well as four other monitoring review committees (Biomonitoring, Air Quality, Ground Water and Drinking Water) were initiated in March 1994 by the ADM, Environmental Sciences and Standards Division, in response to growing concern about provincial and federal budget reductions and the continuing need for environmental monitoring in the management and protection of Ontario's resources.

Specifically, the Surface Water Review Committee Terms of Reference (Appendix A) required us to review existing monitoring activities, client needs, data and reporting requirements, as well as provide options and recommendations for future monitoring directions, addressing the need for integration of monitoring effort, data optimization, partnerships and effective reporting.

The Phase I Report of the Committee presents its findings and recommendations on specific monitoring operational elements, such as sample collection, sample analysis, data management, reporting and program planning; these elements are examined from the perspective of and potential for harmonization, commercialization, modernization and externalization. The Committee also examined the general resource distribution of monitoring resources in ESSD and OD, and considering critical shortfalls, makes recommendations to senior MOEE management for adjustments.

This interim report results from Committee discussions and workshops with invited scientists and engineers, designed not only to respond to the terms of reference but also to promote understanding and to heighten awareness of the problems among the Committee members and leaders of surface water monitoring programs.

We cannot document, in this Report, all the advice and ideas tabled by the Committee members; but we have tried to take these into account in reaching our positions and recommendations.

The Committee recognizes that not all the terms of reference have been fulfilled. Once Senior Management of MOEE has considered the findings and recommendations of Phase I, it is expected that the Committee will be reconstituted to address Phase II of the challenge, the detailed rationalization of the monitoring networks and implementation of the Phase I recommendations. Other current shortcomings can then also be addressed.

ACKNOWLEDGEMENTS

Members of the Surface Water Review Committee, and invited participants in the three workshops, all contributed substantially to an in-depth assessment of MOEE's monitoring efforts - the strengths and weaknesses of current programs, pitfalls to avoid and suggestions for improvement. The substantial contributions of the Surface Water Review Committee and the invited scientists and managers are hereby gratefully acknowledged.

The Surface Water Review Committee endorses and supports the findings and recommendations as presented in this report:

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- ACKNOWLEDGEMENTS (cont'd)

In addition to the Surface Water Review Committee, several MOEE staff were consulted and participated in the Stream Monitoring, Inland Lake Monitoring and Great Lakes Monitoring workshops and other committee deliberations:

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Special recognition and thanks are also given to John Ralston of the Program Development Branch, for his assistance in conducting the review process and preparing the materials for this report.

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- EXECUTIVE SUMMARY

Purpose of Surface Water Monitoring Programs

The MOEE role in the management of water resources is identified, primarily in three Ontario Statutes, the Ontario Water Resources Act, the Environmental Protection Act and the Environmental Assessment Act. Although the activity of developing and maintaining monitoring networks to assess the condition of the natural environment is not explicitly cited in the acts, there is sufficient instruction to clearly show that, if the MOEE is to successfully fulfil its mandate, a comprehensive understanding of the state of Ontario's environment is essential.

Primarily, the purpose of surface water monitoring is to assess the following:

- assess potential impacts of existing and proposed waste discharges, land use changes and lakeshore developments;
- assess the viability of applications for water takings and diversions;
- provide early warning of undetected or emerging problems and issues;
- assess compliance with regulatory controls and monitor effectiveness of remedial actions;
- conduct research into cause-effect relations and assess remedial options;
- provide environmental data necessary for development of watershed management and land use plans;
- identify environmental conditions and trends for public state of environment reporting.

Primary client groups which directly depend on surface water monitoring information to meet their responsibilities, include:

- Operations Division - for regulatory controls and effectiveness monitoring;
- ESSD Branches - to meet intergovernmental commitments, assess effectiveness, research and SOER;
- the General Public - expect reporting on environmental problems, effectiveness, trends;
- Other Ministries and Agencies (MNR, Municipalities, Conservation Authorities, OMAFRA, Ontario Hydro and federal departments - for planning, meeting international commitments (fed.);

Current Monitoring Efforts

The Ministry of the Environment and Energy currently conducts or oversees about thirty surface water programs that generate data on surface water quality and quantity in rivers and streams, inland lakes, the nearshore zones of the Great Lakes and the connecting channels. Staff totalling about 44 person years, primarily in the Environmental Monitoring and Reporting Branch and Science and Technology Branch of the Environmental Sciences and Standards Division and Operations Division, plan, oversee the implementation and report on these programs. Their direct operating expense budgets total about 1.5M (ESSD 1.37M and OD 160K). Substantial additional costs related to sample analysis at the MOEE laboratories

(620 K ODOE, 29 PY at Central Lab) and sample collection costs borne by program partners such as NR, Conservation Authorities, municipalities, industry and cottagers would, significantly increase the value of these programs.

Current monitoring programs are carried out primarily to meet:

- regulatory needs (abatement, approvals, etc.)
- public expectations and accountability (identification of problems, responding to concerns, SOE reporting, etc.)
- intergovernmental agreements (COA, Federal/Provincial Hydrometric Agreement, Countdown 94, Niagara River Toxics Management Plan, etc.)
- local arrangements (i.e. MOEE/MNR, Lake Simcoe, Zebra Mussels, Cottagers of Self Help, CURBS)

Existing river and stream monitoring programs in EMRB comprise mainly the Provincial Water Quality Monitoring Network (PWQMN) and the cost shared Streamflow Network, providing specific water quality trend information and effectiveness monitoring. The majority of resources for stream monitoring are housed in ESSD/STB, dedicated to research monitoring to study the effects of long-range air transport and deposition (including acid rain, the study of mercury in the environment and LSEMS and CURBS), special programs for Lake Simcoe and agriculture runoff management.

Inland lake monitoring is conducted primarily by the ESSD/STB and the Operations Division. STB conducts annual monitoring in cooperation with MNR in Lakes Muskoka, Joseph Rosseau, and Lake Simcoe, and monitors the effects of long-range air transport including acid rain on several lakes around the Dorset area. Operations Division monitors the effects of Sudbury emissions around Sudbury lakes and uses limited resources and cottagers to examine recreational lakes under development pressure.

Great Lakes monitoring programs are conducted mainly in the Great Lakes Areas of Concern (RAP Areas) to assist in the remedial measures assessment and delisting process. Limited investigations are also carried out to provide screening of undetected or emerging problems, i.e. harbours and embayments outside RAP areas and to provide long-term sensing at selected sites throughout the four lakes on a 4-year cycle.

Cost of Operation

The following table summarizes the operating costs of surface water monitoring programs for fiscal year 1993/94:

Division/Branch	ODOE	PY's
ESSD/EMRB	684 K	16.5
ESSD/LSB	711 K	31
ESSD/STB	557 K	17.8
Operations Division	157.5 K	8.2
Other	133 K	0.7
Total	2242.5 K	74.2

Gaps, Needs and Options

Phase I of the Surface Water review addressed the rationalization of general monitoring activities (i.e. streams, inland lakes, Great Lakes), and recommends adjustments to programs and resources. Phase II will address the gaps and needs for the individual monitoring networks, examining parameters, frequencies, geographic distribution and coverage of environmental stressors and issues (i.e. network rationalization).

Gaps and needs for Phase I are reflected in the "Recommended Adjustments" that follow. Options for filling the gaps and the requirements for monitoring relate to review of priorities in research monitoring versus operational monitoring and allocation of existing resources accordingly.

Recommendations

Using the committee positions as documented in the report, a comprehensive set of recommendations and activities were developed, that if implemented, will improve the efficiency and client service of surface water monitoring. Recommendations are provided for each component of a monitoring program, i.e. sample collection, analysis, data management, reporting and planning; actions for implementation can be found in the report.

General Recommendations

- Develop a unifying monitoring framework for stream, inland lakes and Great Lakes monitoring with central coordination.
- Clarify roles of the federal government versus province (COA + CCME Harmonization).
- Establish relative priorities and rationalize resource allocations between internal research monitoring and operational monitoring needs.
- Optimize existing monitoring programs and resource allocations (Phase II).
- Assess potential for further integration of similar monitoring programs in MOEE and MNR.
- Develop a data management system with integrating linkages and ready designated client access to all data bases.
- Improve data management and analyis operations/services.
- Establish a new reporting framework to suit client needs.
- Review and optimize sample analysis operations.
- Establish task groups to evaluate and test promising new methods for sample collection and analysis; allocate research funds accordingly.
- Revise the annual and long-term planning process.

In addition to the general recommendations listed above, the committee has identified the following recommended adjustments that apply to specific program areas.

Stream Monitoring (Recommended Adjustments)

- Redesign and optimize the Provincial Water Quality Monitoring Network.

- Enhanced database analysis and reporting capability to meet OD needs for review and approval functions, including pollution control and land use development.

- Rationalize and redesign the streamflow monitoring network with the federal government, MNR, Ontario Hydro (currently ongoing) enhance to meet client needs.

- Evaluate priority and resource allocations in research monitoring and operational monitoring.

- Re-establish future capability in EMRB to assist OD in special investigations/ monitoring studies (e.g. investigation of spills, waste assimilation, watershed planning, etc.).

Inland Lake Monitoring (Recommended Adjustments)

- Produce and release joint MOEE-MNR management strategies for Lakes Muskoka, Joseph and Rosseau similar to LSEMS, reduce monitoring activity to periodic assessment.

- Continue and promote wider application of the Cottage SELF_HELP programs in Eastern and Mid-Ontario, consider for Northern Region (OD).

- Strengthen Regional recreational lakes monitoring programs to meet lake development pressures in Eastern, Mid-Ontario and North Ontario (OD).

- Review monitoring for effectiveness of Countdown Acid Rain and local emission reduction programs in impacted lakes (ESSD, OD).

- Evaluate priority and resource allocations in research monitoring and operational monitoring.

- Establish resources in EMRB for development and implementation of a coordinated framework for inland lake monitoring

Great Lakes Monitoring (Recommended Adjustments)

- Work closely with PDB, federal government, MNR and OMAFRA to develop integrated monitoring programs to meet COA commitments; remaining resources in EMRB are inadequate to meet monitoring needs for:

    - RAP areas delisting
    - Lake Ontario, Erie, Superior/Nipigon Lakewide Management Plans (LaMPs)
    - Field and Marine Operations

- Continue Screening Investigations in areas and issues outside RAP areas to identify existing and emerging issues/problems requiring abatement.

- Continue cycle of Long Term Sensing Site monitoring in support of COA (LaMPs) and SOER.

- Re-establish periodic nearshore monitoring program as complement to federal open-lake monitoring, essential for the understanding of the nearshore environment (future).

CHAPTER 1 - WHY DO WE NEED SURFACE WATER MONITORING?

Historically, and current to this day, surface water monitoring, and environmental monitoring in general, have provided the basis for public attention and concern and also for government action to restore, protect and enhance the quality of surface waters in Ontario.

Surface water monitoring of streams, inland lakes and the Great Lakes, must provide the government with the tools and information needed to demonstrate its public accountability and responsibility in meeting its mandates and legislative and statutory obligations.

1.1 Definition of Surface Water Monitoring

In the context of this review, "Surface Water Monitoring" is a general term applied to the collection of all information on surface water quality and quantity, and for many different purposes, including the conduct of research. For clarification, the following definitions are offered as variations of "monitoring" that have been adopted by the Review Committee (after Hellawell, 1978):

Investigation:

An exercise in which a set of standardized observations is taken from a station or stations within a short period of time to furnish qualitative or quantitative descriptive data.

Surveillance:

A continued program of surveys or investigations systematically undertaken to provide a series of observations over time.

Monitoring:

Surveillance undertaken to ensure that previously formulated standards are being met.

1.2 Purpose of Surface Water Monitoring

Surface water monitoring of Ontario streams, inland lakes and the Great Lakes provides the Ministry and its scientific community with the information needed to meet public expectations and agreements and to comply with provincial mandates related to water management. The MOE role in the management of water resources is identified, primarily in three Ontario Statutes, the Ontario Water Resources Act, the Environmental Protection Act and the Environmental Assessment Act. Although the activity of developing and maintaining monitoring networks to assess the condition of the natural environment is not explicitly cited in the acts, there is sufficient instruction to clearly show that, if the MOEE is to successfully fulfil its mandate, a comprehensive understanding of the state of Ontario's environment is essential. Comprehensive Monitoring of the surface waters is an essential component of achieving this understanding.

Primarily, the purpose of surface water monitoring is the following:

- assess potential impacts of existing and proposed waste discharges, land use charges and lakeshore developments
- assess viability of applications for water takings and diversions
- provide early warning of undetected or emerging problems and issues
- assess compliance with regulatory controls and monitor effectiveness of remedial actions
- conduct research into cause-effect relations and assess remedial options
- provide environmental data necessary for development of watershed management and land use plans
- identify environmental conditions and trends for public state of environment reporting.

Primary client groups which directly depend on surface water monitoring information to meet their responsibilities, include:

- Operations Division - for the regulatory control of waste discharges, management of lakeshore development, land use, water takings and compliance assessment;
- ESSD Branches - to meet intergovernmental commitments, assess effectiveness of remediation and control programs, manage exotic invasions, research cause-effect and SOER;
- the General Public - for reporting on environmental problems, effectiveness of control and environmental trends;
- Other Ministries and Agencies (MNR, Municipalities, Conservation Authorities, OMAFRA, Ontario Hydro, and federal departments - for fisheries management planning, municipal discharge management planning, watershed and land use planning, agricultural management planning and Hydro development planning; federal international commitments.

1.3 MOEE Benefits of Monitoring

In conducting effective, well planned surface water monitoring programs, the Ministry can place itself in a fairly confident position in meeting its public expectancies, agreements and statutory mandates. Here are some crucial benefits that can be accrued by MOEE by having good monitoring information available:

- knowledge of current state, compliance, trends for decision making
- proactive knowledge of existing or emerging problems
- definition of cause-effect relations (research) for predicting impacts
- ability to predict impacts (modelling) and assess options
- delisting of Areas of Concern based on restoration of impaired uses
- scientific basis for environmental standards for protection and prevention
- justification for policy development where required for stricter control
- illustrate effectiveness of abatement for public accountability
- approval of CofA applications, protecting environmental quality
- approval of discharge proposals where capacity exists for waste assimilation
- approval of proposals for water taking where quantity is adequate
- approval of lakeshore development where capacity exists
- assess compliance with CofA's to show enforcement
- monitor effectiveness of abatement activities for public accountability
- SOE reporting to improve public awareness

CHAPTER 2 - THE SURFACE WATER REVIEW STRATEGY

To ensure the avaiability of useful Committee guidance in time for the 95/96 planning period, the review of the Surface Water Monitoring program was staged into two phases. Phase I, being the program review phase, was designed to examine general monitoring needs in the ESSD and the OD, examining current programs and resource distributions and, more specifically, the shortcomings and improvements needed to make current program operations more efficient and effective.

Phase II, to be initiated in early 1995, is to address specifics of network rationalization and implementation of Phase I recommendations, once sanctioned by senior management of MOEE.

2.1 Challenges

The Surface Water Review Committee was initiated by the Assistant Deputy Minister and the Directors of the ESSD in mid 1994, in response to a number of provincial and corporate challenges:

- provincial deficit reduction
- changing priorities in MOEE
- commercial/business approach in government operations
- MOEE shift to "multi-media" monitoring
- little movement by sectoral programs to integrate
- strengthened public concern for aquatic life and human health effects
- acid rain issue no longer a primary public concern
- Countdown '94 targets have been met
- shift of responsibility for compliance monitoring to proponent
- 1989/90 to 1994/95: up to 60% cut in some operational monitoring budgets
- 1993: consolidation of monitoring programs in EMRB
- 1994: new COA Great Lakes Strategy

2.2 Elements of the Surface Water Review Strategy

After several Committee discussions on how to approach the review of surface water monitoring programs, deadlines dictated that the process be broken into two phases. The first phase was to examine, in general terms, the adequacy and suitability of three categories of monitoring (stream, inland lakes, Great Lakes) in meeting the readily identifiable priority needs of ESSD, OD and others. Phase II, as a follow-up, is to address details of network rationalization and redesign.

Phase I of the surface water monitoring review has concentrated on:

A: Program Rationalization
B: Program Operations Review

A. Program Rationalization

In rationalizing the surface water monitoring programs from an overview perspective, the following process was considered:

- identify objectives for monitoring and benefits to MOEE
- identify MOEE mandates and agreements that require surface water monitoring
- identify environmental issues, potential for ecological impacts, potential for impact on beneficial uses, geographic distribution, as a basis for future network rationalization (Phase II)
- identify monitoring needs and set priorities for OD, ESSD, other ministries and external agencies, as well as public expectations
- documentation and review existing complementary programs and recommend adjustments for:
  - stream monitoring
  - inland lake monitoring
  - Great Lakes monitoring
- assess adequacy of current monitoring programs for other client use, such as:
  - economic linkages
  - sustainable development
  - risk assessment
  - land use and watershed planning
  - etc.

B. Program Operations Review

Program operations review refers to the assessment of operational monitoring elements such as sample collection and analysis, with respect to shortcomings and potential improvements towards efficiency and effectiveness in meeting client needs. The following process was undertaken:

- Develop Committee positions on:

  - Harmonization
    - program coordination, cooperation
    - potential for new agreements, partnerships
    - potential for integration
  - Modernization
    - use of advanced or up to date technologies in the field and office

  - Externalization
    - the potential for privatizing field or office operations

  - Commercialization
    - identification of products/services
    - assessment of market demand
    - potential for revenue generation

- Apply the committee positions on harmonization, modernization, externalization and commercialization to the following operational monitoring elements, and develop recommendations for improvement of effectiveness and efficiency in:

  - sample collection
  - sample analyses
  - data management
  - reporting
  - program planning

Phase II of the surface water monitoring review, to be undertaken in 1995, will concentrate on network rationalization and implementation of ***Phase I*** recommendations.

CHAPTER 3 - DOCUMENTATION OF EXISTING MONITORING PROGRAMS AND NEEDS

3.1 Current Programs

The Ministry of the Environment and Energy currently conducts or oversees about thirty surface water programs that generate data on surface water quality and quantity in rivers and streams, inland lakes, the nearshore zones of the Great Lakes and the connecting channels. Staff totalling about 43.5 person years, primarily in the EMRB and STB of Environmental Sciences and Standards Division (25.5) and Operations Division (8), plan, oversee the implementation and report on these programs. Their direct operating expense budgets total about 1.5 million dollars in 1994/95 (ESSD $1.37M, OD $160K). Substantial additional costs related to sample analysis at the MOEE laboratories (620 K ODOE, 29 PY at Central Lab) and sample collection costs borne by program partners such as MNR, Conservation Authorities, municipalities, industry and cottagers would significantly increase the value of these programs.

Table 1 provides a listing and brief description of current surface water quality and quantity monitoring programs, including an indication of current resources applied by the lead branch or region to each program. A listing of applications of the information generated and a listing of major program clients is also provided.

3.2 Examples of Current Applications for Monitoring Data

In order to understand better how the surface water monitoring programs in Table 1 are used in ESSD and OD, some examples are presented to show how monitoring information is used from stream, inland lake and Geat Lakes monitoring programs:

- Stream Monitoring

  ESSD
  - •• assess trends in nutrients and chemicals in Ontario streams; identify areas of improvement due to changing agricultural, municipal and industrial practices.
  - •• monitor trends in pollutant loadings to the Great Lakes to assess effectiveness of agricultural and urban runoff controls.
  - •• provide statistical water quality information to allow regions to assess the capacity of streams to receive additional waste effluent.

  OD
  - •• approvals for effluent discharges based on stream data to judge validity of proponents' assessment of impact.
  - •• approvals for water taking permits based on streamflow monitoring records.
  - •• restrictions on industrial/municipal effluent discharges based on statistical low flow monitoring of receiving streams.

RIVER / STREAM PROGRAMS							
PROGRAM CODE	PROGRAM	DESCRIPTION	LEAD BRANCH/REGION	PY	ODOE ($K)	APPLICATIONS	PRINCIPAL CLIENTS
EMRB-4	**Provincial Water Quality Monitoring Network (PWQMN) - Water**	600 routine stations throughout Ontario - sampled monthly for over 60 physical, chemical and microbiological parameters - operated continuously since 1964; sampling by Regions, Conservation Auth.'s and private individuals.	EMRB (OD, CAs)	3.0	46	C of A; ecosystem health, effectiveness; human health; NPS - rural; NPS - urban; trends; flow regulation	OD, ESSD, COA, MNR, CAs, consultants, OCWA, EC, public, industry, municipalities, NGOs
EMRB-5	**PWQMN - Sediment**	Enhanced monitoring of sediments at the mouths of 17 major tributaries draining to the Great Lakes - sampled for nutrients and other chemical pollutants - operated continuously since 1980	EMRB (EC)	0.3	40	C of A's; ecosystem health; modelling, trends, loadings	ESSD, OD, COA, OMAFRA, EC, consultants
EMRB-6	**PWQMN - Pesticides**	Enhanced monitoring for agricultural pesticides at the mouths of three large river basins (Grand, Thames, Saugeen) draining southwestern Ontario. Addresses concerns related to the transport of herbicides which run off agriculturally active areas.	EMRB (OMAFRA)	0.2	-	C of A's; ecosystem health, modelling, trends, loadings	ESSD, OD, COA, OMAFRA
OD-12	**PWQMN - Participation**	Collect samples at specified stream locations in support of PWQMN	OD	1.0	18	as above	as above
EMRB-7	**Water Quality (Streamflow) Network**	Streamflow monitoring at 400 + gauged locations on river basins throughout Ontario for baseline flow information. Cooperative program with the Federal government.	EMRB (MNR, EC, OD, Ont. Hydro)	0.5	106	C of A's, water taking; trends; flow regulation	OD, ESSD, COA, MNR, CAs, consultants, EC, industry, municipalities
OD-11	**Certificate of Approval Compliance Assessment**	Assessments undertaken by a wide range of dischargers (industrial, municipal and private) throughout Ontario to assess compliance with allowable effluent concentrations and loadings specified in MOEE Certificates of Approval	All MOEE Regions (Industries and municipalities)	na	na	Compliance; effectiveness; modelling; trends	OD, MISA, industry, municipalities, consultants, public, NGOs
PDB-2	**Heritage Estates Stormwater Management Study**	Assessment of the effectiveness of stormwater ponds for pollutant removal and the impact of stormwater effluents on receiving streams	PDB	0.6	50	NPS-urban; ecosystem health; modelling; research; effectiveness	ESSD, OD, EC, municipalities, MNR, CAs, consultants
SDB-1	**Rouge River Watershed Sediment Study**	Field verification and refinement of Provincial Sediment Quality Guidelines with a view to establishing watershed-specific guidance on sediment evaluations	SDB	0.1	5.0	Ecosystem health; NPS-urban and rural; research	ESSD, OD, EC, MNR
STB-1	**Agricultural Pilot Watershed Study**	A watershed-based research and demonstration program to evaluate long-term benefits of conservation farming practices in reducing soil erosion and accompanying solids and phosphorus loadings to streams in agricultural areas. (Formerly SWEEP)	STB (EC, OMAFRA)	0.2	25	NPS - Rural; ecosystem health; effectiveness; research	ESSD, OD, COA, Agriculture Canada, OMAFRA, farming industry, EC, academia
STB-2	**Clean Up Rural Beaches (CURB)**	To provide long term trends of water quality changes associated with the remediation of rural pollution problems as well as site-specific improvements associated with site clean ups. CURB is a 10 year, $57 million capital grant assistance program.	STB (CAs)	1.0	2.0	NPS - Rural; ecosystem health; effectiveness; research	ESSD, OD, CAs, public, farming industry

PROGRAM CODE	PROGRAM	DESCRIPTION	LEAD BRANCH/REGION	PY	ODOE ($K)	APPLICATIONS	PRINCIPAL CLIENTS
STB-7*	**Lake Simcoe Environmental Management Study Tributary Monitoring**	To undertake water quality monitoring of nutrients and other substances in tributaries flowing to Lake Simcoe	STB (LSRCA, MNR)	1.2	40	Ecosystem health, effectiveness; fisheries management; trends; NPS rural	ESSD, OD, MNR, Lake Simcoe Region CA, public
STB-3, 4	**Long Range Transport Chemical/Biological - Streams/Lakes - Inland Lakes**	To assess the long-range transport of acids, nutrients, contaminants and other substances on lakes and streams; quantification of cause-effect relationships so that models related to the control of these substances can be developed	STB (EC,OD, Academial)	10.6	285	Modelling; ecosystem health; NPS-atmospheric; research; trends; warning	ESSD, MNR, EC, OD, NGOs, public academia,
			INLAND LAKE PROGRAMS				
STB-6	**Muskoka Lake Study**	Cooperative study with MNR to determine the responses of lakes Muskoka, Joseph and Rosseau to shoreline development, exotic species, contaminants, fish exploitation, acidification and sewage effluent	STB (MNR)	1.7	40	Lake development; ecosystem health, effectiveness, exotics; fisheries management; modelling; research; trends	ESSD, MNR,OD,public, municipalities, NGOs, academia
STB-5	**Occurrence of Mercury in the Environment**	To document the occurrence of Hg in the environment and develop models to describe dispersion, bioaccumulation and toxicity. Precipitation sampling.	STB (EC, academial)	1.5	65	Ecosystem health; human health; research; modelling; trends; NPS-atmospheric	ESSD, OD, MNR, public, EC, industry, academia
STB-7	**Lake Simcoe Environmental Management Study (LSEMS) Implementation Phase**	To evaluate factors influencing physical and chemical limnology of Lake Simcoe with reference to P loading remediations; evaluate factors influencing the lakes's plankton communities; identify spatial differences and temporal trends in trophic status	STB (LSRCA)	1.4	100	Ecosystem health; effectiveness; fisheries management; modelling; NPS-rural; trends	ESSD, OD, MNR, Lake Simcoe CA, public
OD-1	**Recreational Lakes Program Eastern Region**	To provide baseline water chemistry, benthos and phytoplankton data for making management decisions with respect to lake development and management of lake trout lakes (MNR)	Eastern Region (MNR)	1	10	Lake development; fisheries management; ecosystem health; trends	OD, MNR, public, municipalities, consultants, developers, academia
OD-2	**Cottagers Self-Help Program Eastern Ontario**	To assess the trophic status of recreational lakes, cottagers collect samples and make field observations. MOEE provides analytical support and data interpretation services.	Eastern Region (Cottagers)	0.5	7	Lake development; ecosystem health; effectiveness; trends	Public, OD, MNR, municipalities
OD-8	**Cottagers Self-Help Program Mid-Ontario**	To assess the trophic status of recreational lakes, cottagers collect samples and make field observations. MOEE provides analytical support and data interpretation services.	Mid-Ontario Region (Cottagers)	0.8	2	Lake development; ecosystem health; effectiveness; trends	Public, OD, MNR, municipalities
OD-3	**Spring Phosphorus Program Northern Ontario Region**	To collect spring turn over lake water samples for phosphorus and other relevant water chemistry at selected lake in the Northern Region where potential lakeshore development has been identified.	Northern Ontario Region (MNR)	0.2	1.5	Lake development; ecosystem health; trends	OD, MNR, municipalities, public, developers
OD-10	**Spring Phosphorus Program Mid-Ontario Region**	To collect spring turn over lake water samples for phosphorus analysis at selected lakes in the Mid-Ontario Region to assess lakeshore development capacity.	Mid-Ontario region (MNR)	0.2	1.5	Lake development; ecosystem health; trends	OD, MNR, municipalities, public, developers
OD-4	**APIOS-Lake Sensitivity**	To collect water chemistry samples from lakes in northern Ontario for sensitivity to acidic precipitation	Northern Ontario Region	1	30	Effectiveness; research; trends; ecosystem health; modelling; NPS-atmospheric	OD, MNR, public

*STB 3,4 also applies to Inland Lake monitoring

PROGRAM CODE	PROGRAM	DESCRIPTION	LEAD BRANCH/REGION	PY	ODOE ($K)	APPLICATIONS	PRINCIPAL CLIENTS
OD-6	**Sudbury Extensive Lakes**	To sample, once annually, 45 lakes within the zone of influence of the Sudbury smelter emissions for pH, alkalinity and metals to assess the adequacy and effects of emission controls.	Mid-Ontario Region	0.3	8	C of A's; effectiveness; trends	OD, ESSD, industry, municipalities, NGOs, academia
OD-7	**Sudbury Intensive Lakes**	To assess chemical and biological conditions in the water and sediment of 6 lakes within 100 km, of Sudbury. Date used to evaluate the adequacy of controls related to the Sudbury emission control programs	Mid-Ontario Region (MNR)	0.9	32	C of A's; effectiveness; research; modelling; trends	OD, ESSD, industry, municipalities, NGOs, academia
			GREAT LAKES				
EMRB-2	**Great Lakes RAPs Support**	At 17 Areas of Concern, identify environmental conditions and pollution sources causing environmental degradation, measure the impact of sources, recommend remedial actions and measure the effectiveness of remedial measures as they are implemented.	EMRB (OD, EC, HC, AC, MNR, OMAFRA)	3.5	63 (EMRB) 78 (PDB	C of A's; effectiveness; ecosystem health; human health; trends	ESSD, OD, COA, RAP Teams, EC, municipalities, industry, public, consultants, academia
EMRB-10	**Water Intakes Monitoring Program**	Sampling raw water at water works intakes around the Ontario shoreline of the Great Lakes to monitor for seasonal and long term changes in nutrient levels and productivity. A unique set of information for observing changes in the GL.	EMRB	1	9	Trends; ecosystem health	ESSD, OD, public, academia
EMRB-1	**Great Lakes Screening Level Investigations**	Assessments of GL embayments, harbours and tributary mouths - outside areas of concern; recommend remedial actions and measure the benefits of remediation, identify emerging problems	EMRB (OD)	1	90	C of A's; ecosystem health; human health; effectiveness; warning, exotics	ESSD, OD, COA, EC, MNR, municipalities, industry, NGOs, public, consultants
EMRB-3	**Long Term Sensing**	Sediment and water quality are periodically monitored using chemical, physical and biological measures at 48 index stations throughout the GL and connecting channels on a 4-year cycle (i.e. 1 lake/yr.) to assess trends and identify reference conditions	EMRB	1	80	trends, warning; ecosystem health; exotics	ESSD, OD, EC, MNR, public COA-LaMPs
EMRB-8	**Drinking Water Surveillance Program**	To sample over 125 municipal drinking water systems (raw and treated water) for a wide range of chemical parameters. The raw water sampling component is of particular interest in contributing to the surface water quality database	EMRB	2.8	122	Trends, ecosystem health, warning	ESSD, OD, EC, MNR, public municipalities
EMRB-9	**Great Lakes Marine and Field Operations**	Providing vessel and sampling crews in support of Great Lakes investigations and monitoring	EMRB	6 + SS	250	Effectiveness, ecosystem health, human health, trends, exotics warning	ESSD, OD, COA, MNR, municipalities, public
STB-8	**Surface Water Modelling**	To collect water, sediment and biological samples for the calibration of models used for a variety of purposes including deriving effluent loading limits, assessing remedial options, assessing spill impacts and designing monitoring strategies	STB	5	50	Modelling; C of A; effectiveness; human health; ecosystem health; research	ESSD, OD, COA/RAP's, SAC, EC, consultants, municipalities, industry

Note: Identified P-Y and ODOE figures exclude laboratory analytical costs and costs incurred by other agencies. Where other agencies contribute significant resources, this is noted in brackets under the "Lead Branch" column.

3.2 (cont'd)

- Inland Lakes Monitoring

ESSD

- •• determine response of specific lakes to shoreline development and other environmental stressors, such as acid precipitation, for use in water and fisheries management (eg. Muskokas, Lake Simcoe)
- •• document and model the occurrence, dispersion, bioaccumulation and effects of specific chemicals of concern (eg. Hg), identifying sources and impacts

OD

- •• collect baseline data where possible for management decisions regarding lakeshore development and fisheries management
- •• monitor trophic status of recreational lakes, where possible as an indicator of environmental conditions, problems, improvements etc.
- •• assess the sensitivity of regional lakes to local and long range acid precipitation, and monitor the effectiveness of emission controls

- Great Lakes Monitoring

ESSD

- •• periodic investigations of potential problems in harbours and embayments outside known Areas of Concern
- •• quantification and assessment of environmental problems, sources and impaired beneficial uses in 17 RAP areas
- •• ambient water monitoring in RAP areas to define effectiveness of RAP implementation; provide evidence of restoration of impaired uses for delisting
- •• cyclic monitoring of long-term sensing sites to attempt to define changes in the aquatic ecosystem due to basin-wide activities
- •• field measurements of flow and chemical dispersion for calibration of spill models and models for assessment of effluent control options

OD

- •• assistance to ESSD in RAP area investigations and cooperative site-specific assessments to assess impact of chemical discharges, compliance and trends

3.3 MOEE and Other Priority Needs for Surface Water Monitoring Data

In order to assess the adequacy of existing monitoring programs in meeting priority needs, it is important to identify and prioritize needs for surface water monitoring data. The Committee has identified the applications which have an essential need for surface water monitoring information and listed them in order of priority for Operations Division, Environmental Science and Standards Division and the public. The Committee has also identified the needs of other ministries and agencies that depend on MOEE monitoring information to carry out their responsibilities.

Table 2 summarizes the priority needs/applications for surface water monitoring data and identifies the monitoring programs (by code) that address that need.

TABLE 2 Priority Needs of MOEE and Others for Surface Water Monitoring Data

TABLE 2A - Operations Division (in order of priority)	
OD requires surface water monitoring data to fulfil the following functions:	Programs* that serve the needs:
1. Review of applications for approval of waste discharges	EMRB-1/2/4/7 STB-6/7/8 OD-1/3/10
2. Review of applications for land use change and lakeshore development	EMRB-1/2/4/7 STB-6/7 OD-1/2/3/8/10
3. Assess significance of reported no -compliance	EMRB-1/2/4/6 STB-6/7/8 OD-1/3/10
4. Assess applications for approval of water taking permits	EMRB-7
5. Assess effectiveness of controls (control orders, C of A's, remedial action, restoration, prevention)	EMRB-2/4/5/6 STB-1/2/3/4/6/7/8 OD-6/7/11 PDB-2
6. State of Environment reporting	EMRB-1/2/3/4/7/8/10 STB-3/4/5/6/7 OD-1/2/3/4/6/7/8/10/11

* see Table 1 for description of programs

TABLE 2B - **Environmental Sciences and Standards Division** (in order of priority)	
ESSD requires surface water monitoring data to fulfil the following functions:	Programs* that serve the needs:
1. Provide monitoring service essential for OD environmental review and approval functions	EMRB-2/4/7 STB-6/7 OD-6/7
2. Meet intergovernmental agreements/commitments: i) COA - Great Lakes Ecosystems (reflecting GLWQA) ii) Canada-Ontario Hydrometric Agreement iii)Countdown '94 iv) Lake Simcoe Env. Mgt. Strategy (LTEMS) v) Niagara R. Toxics Mgt. Plan (NRTMP)	EMRB-2/4/7 STB-6/7 OD-6/7
3. Provide early warning of new or emerging problems	EMRB-1/3/4
4. Assess effectiveness of other local, regional or international remediation and control programs i) Industrial ii) Municipal iii) Agricultural iv) Sediments v) Atmospheric	EMRB-2/4/5/6 STB-1/2/3/4/6/7/8 OD-6/7/11 PDB-2
5. Impact of exotic species on surface water	EMRB-3/4
6. Research in cause-effect relations and predictive modelling Scientific basis for environmental standards development	EMRB-2 STB-1/2/5/6 OD-6/7, SDB-1
7. State of the Environment reporting	EMRB-1/2/3/4/7/8 STB-3/4/5/6/7 OD-1/2/3/4/5/6/7/10/11

TABLE 2C - **Public Expectations** (in order of priority)	
The public expects MOEE to provide information on the following:	Programs* that serve the needs:
1. Identification of environmental (SW)problems (existing/new/emerging) that have potential for impact on: i) human health ii) aquatic life iii) other ecosystem health	EMRB-1/2/3/4/5/6/7/8/10 STB-1/2/5/6/7
2. Monitor and report on effectiveness of control programs (eg. regulations)	EMRB-2/3/4/6 STB-1/2/3/4/7 OD-2/6/7/8/11 PDB-2
3. Monitor, interpret and report on significant environmental changes/trends	EMRB-1/2/3/4/5/6/10 STB-3/4/5/6/7 OD-1/2/3/4/6/7/8/10/11

TABLE 2D - **Other Resource Ministries/Agencies** (not in order of priority)	
Other ministries and resource agencies have essential needs for surface water monitoring information in the following operations:	Programs* that serve the needs:
1. OMNR - water quality information for direct use in fisheries management	EMRB-3/4/5/6/7/9/10 STB-3/4/6/7 OD-4/6/7
2. Municipalities - assess impact of municipal discharges (eg. SS, CSO, STP's) for of beneficial water uses (eg. mainly recreational), land use development and watershed planning	EMRB-1/2/4/7/9 STB-6/7/8 OD-11 PDB-2
3. Cons. Authorities - water quality and quantity monitoring for flow regulation and watershed planning	EMRB-4/5/6/7 STB-1/2 SDB-1
4. OMAFRA - identification of impacts of local and regional agricultural practices and effectiveness of control programs (eg. pesticides)	EMRB-4/5/6/7 STB-1/2
5. Ontario Hydro - partnership in streamflow monitoring; assess potential impacts of proposed new developments	EMRRB-4/7
6. Federal Departments - partnerships in water quantity monitoring in Ontario; meet federal international commitments (eg. GLWQA, Countdown '94, NRTMP)	EMRB-2/3/5/7 STB-4 OD-4/6/7

Table 3 attempts to assess the adequacy of the monitoring programs in meeting various information needs identified in Table 2. It also provides a cursory assessment of other more indirect external surface water data applications, such as economic assessments, risk assessment, etc.

It is evident from Table 3 that current monitoring programs, in general, are not adequate or were not designed to address the specific information needs assessed. Phase II (network rationalization and design) will have to take these needs into consideration.

TABLE 3 ADEQUACY OF MONITORING PROGRAMS IN MEETING INFORMATION NEEDS

CATEGORY/PRIORITY *	ADEQUACY	SUGGESTIONS
Discharge Regulations TABLE 2A - 1, 3, 4 TABLE 2B - 6 TABLE 2D - 5	Most existing river and inland lake monitoring programs are not adequate for the development of receiving water-based discharge regulations such as C. of A.s. Concerns addressed in "Waste Receiving Capacity" and "Modelling and Extrapolation" described above directly apply here. When a new or expanded discharge is proposed, the proponent is required to collect information in order to gain some understanding of the receiver and develop appropriate discharge limits for MOEE consideration. Without adequate information of its own, the MOEE regional staff are in a difficult position to determine the adequacy of information collected. In some cases, such as RAP sites, data from monitoring programs have been adequate to contribute information to setting limits for discharge regulations.	It is unlikely that general monitoring programs will ever be able to provide the spatial and temporal intensity of information required for developing discharge regulations. This responsibility has been handed to the proponent. However, adequate data must be collected through monitoring programs to permit MOEE to judge the adequacy of site studies undertaken by proponents. Communication must be maintained between the regions and monitoring program managers to assure adequate planning is in place to provide needed data and specialized technical support
Waste Receiving Capacity TABLE 2A - 1, 3, 5 TABLE 2B - 1, 6 TABLE 2D - 2	Water quality and quantity monitoring information is essential for determining acceptable waste receiving capacities. Reduced funding to operate monitoring programs has lead to information gaps for areas of Ontario. If monitoring programs continue to shrink, the availability and reliability of information will be gone and MOEE will not be able to live up to its responsibilities.	Proper long-term planning of monitoring programs including information on proposed development initiatives is essential in order to ensure that water quality and quantity information are available when needed. Further, facility to initiate short-term (3 to 5 years) data collection stations can vastly improve the efficiency and effectiveness of monitoring programs. See also comments on waste assimilation studies under sustainable development. This information is essential for Regional Operations.
Land Use/Watershed Plans TABLE 2A - 2 TABLE 2B - 4 TABLE 2C - 3 TABLE 2D - 2, 3, 4	Most monitoring programs are not designed or operated to assess the often subtle environmental effects of land use changes or to provide specific guidance in watershed planning. Data collected over time can show the overall impacts of change on water quality and quantity. Special purpose monitoring programs could be designed to provide this information as part of a comprehensive watershed investigation	Proposed watershed investigations should be considered as part of a 5-year planning projection for monitoring programs and appropriate monitoring programs could be designed assess the impact of existing land uses and predict the impact of future changes.

TABLE 3 ADEQUACY OF MONITORING PROGRAMS IN MEETING INFORMATION NEEDS

CATEGORY/PRIORITY *	ADEQUACY	SUGGESTIONS
Sustainable Development TABLE 2A - 2, 6 TABLE 2B - 2, 4, 7 TABLE 2D - 2, 4, 5	While there is likely substantial amounts of chemical/physical information available to address sustainable development, general programs, particularly the data interpretation and reporting components, have not, traditionally, been designed to meet this type of application beyond assessing temporal and spatial trends. More programs focusing on biological conditions and ecosystem health are needed to complement chemical/physical monitoring.	Procedures to interpret monitoring data to assess sustainable development thresholds, incorporating chemical, physical and biological components, should be developed, tested and refined and may lead to refinement in sampling and analytical requirements. Waste assimilation studies (short term, site-specific intensive investigations that clearly identified sustainable use of rivers and lakes for treated wastewater disposal) were used extensively in MOEE until 1987. This type of assessment, if resurrected, could be refined for determining sustainability for a wide variety of applications.
Effects of Abatement TABLE 2A - 2 TABLE 2B - 4 TABLE 2C - 2 TABLE 2D - 2, 4	While several general monitoring programs have sampling stations located downstream/current of wastewater dischargers, their value in assessing effectiveness of abatement or control measures is spotty. A comprehensive picture of the environmental effects of controls normally requires many stations sampled at an increased frequency for a specific selection of parameters. Specifically-designed monitoring programs, like the APIOS Lake Sensitivity Studies or the Great Lakes RAP Investigations, work well to measure the effectiveness of abatement.	Arguments have been made that effectiveness monitoring in the receiving environment should become the responsibility of all dischargers and that stations established to monitor effects of abatement should be dropped from general monitoring programs. Monitoring programs designed specifically to monitor the effectiveness of abatement for a specific situation (e.g. smelter emission controls at Sudbury) or for global problems (acid precipitation controls) should be maintained but reviewed on a regular basis to determine their on-going value to the MOEE.
Risk Assessment Related to Exposure TABLE 2A - 3 TABLE 2B - 3, 6 TABLE 2C - 1	Monitoring data can provide qualitative information related to exposure risks for aquatic life by comparing measured concentrations against such standards as PWQO for aquatic communities. Drinking water monitoring and fish consumption guidelines for humans are two programs related to human health risk.	To adequately meet risk assessment needs monitoring programs must be designed to collect information where the exposure is likely to occur, when and for how long it is to occur and include the range of parameters (often large) that pose a risk. These needs must be defined on a case by case basis.

TABLE 3 ADEQUACY OF MONITORING PROGRAMS IN MEETING INFORMATION NEEDS

CATEGORY/PRIORITY *	ADEQUACY	SUGGESTIONS
Early Warning TABLE 2B - 2, 3, 5 TABLE 2C - 1	Most monitoring programs are designed to monitor known problems with known parameters. As a result there is little chance that such programs will provide early warning of emerging issues. Monitoring programs can be designed to meet this need but require careful selection of station locations and analytical parameters. Programs employing sensitive biological indicators probably stand the best chance of sensing emerging problems	While continuous monitoring programs can be designed to sense early warning of emerging problems, they are expensive and probably have little chance of success. All aspects of an early warning monitoring program- sampling, analysis and data interpretation - must be meticulous. The alternative, less expensive solution is to conduct synoptive investigations where one suspects that there may be an undetected problem.
Trends Assessment TABLE 2A - 6 TABLE 2B - 2, 4, 5,6,7 TABLE 2C - 2, 3 TABLE 2D - 4, 6	Monitoring programs are well suited to both spatial and temporal trends evaluation. Prerequisites include the proper selection of sampling locations and parameters, consistency in sampling and analytical procedures and long-term commitment to sample collection.	Trends assessment must always be a fundamental consideration when developing or revising a monitoring program. Compatibility of data bases permitting assessment of cause-effect relationships adds substantially to the value of data and facilitates such uses as economic assessment-benefit analysis and effectiveness monitoring.
Economic Assessment - Benefit Analysis TABLE 2A - 5 TABLE 2B - 2 TABLE 2C - 4, 6 TABLE 2D - 2	Most general programs are not fundamentally designed to meet this type of application and with little feedback from economists their value is hard to judge. Some specific programs such as RAPs and Sudbury Lakes are specifically designed to directly address the environmental benefits of remedial actions.	Properly designed monitoring programs can satisfactorily meet this need; but, input from economists in the design of such programs is needed. Specifically-designed studies can be expensive and require a long-term dedication of resources to identify changes, before and after an activity or remediation.
Research TABLE 2B - 3, 6 TABLE 2D - 1	General monitoring programs are not designed to provide information to support research; however, specifically designed monitoring programs are essential to many research activities. Research related to identifying and developing new monitoring methods is not well supported within MOEE.	Resource requirements for monitoring programs conducted in support of research should be sourced from research funds. Funding of research related to improving the efficiency and effectiveness of MOEE monitoring programs should be given priority consideration. Research monitoring requires intense monitoring to establish cause-effect relations.

TABLE 3 ADEQUACY OF MONITORING PROGRAMS IN MEETING INFORMATION NEEDS

CATEGORY/PRIORITY *	ADEQUACY	SUGGESTIONS
Modelling and Extrapolation TABLE 2A - 1, 2, 4 TABLE 2B - 6 TABLE 2D - 5	General water quality monitoring data are, in most cases, inadequate for anything more than the most basic modelling purposes. Normally, modelling needs are met by specifically designed programs with greater station density and sampling frequency. Water quality monitoring records cannot be extrapolated spatially with any degree of confidence. Continuous water quantity monitoring network data are essential and ideal for modelling purposes. With an adequate distribution of stations in a given part of the Province, water quantity records can be extrapolated spatially with a good degree of confidence.	With the virtual demise of intensive surveys to collect data for predictive modelling, monitoring records may form the only database available for this purpose. As part of the 5-year planning cycle, areas requiring the application of models should be identified and modellers must work with monitoring program managers to ensure that programs are designed to meet the modellers' specific needs. Similarly, the design of monitoring programs should incorporate the strategic location of sampling stations that are representative of different watersheds and lakes so that water quality data extrapolation can be minimized. A widespread and continuous water quantity network is essential for modelling purposes with permanent reference stations and short-term sites, determined as part of the 5-year planning cycle, to meet identified needs.
State of the Environment Reporting	All monitoring programs contribute in some way or another to an understanding of the state of the environment; however, because of deficiencies related to spatial distribution of sampling stations and incompatibility among monitoring programs, comprehensive reporting on the state of Ontario's aquatic environment is very difficult and time consuming. Chemical/physical and most biological monitoring programs do not provide information on ecosystem health.	Staff responsible for SOE reporting should be involved in the long term and annual planning of monitoring programs. It then becomes a question of available resources to collect the information needed for SOER. Monitoring programs should be designed to address the following questions which are fundamental to SOE reporting: What is happening? Why is it happening? Why is it significant? Greater communication among monitoring program managers and greater compatibility of programs (sampling, analysis and data management) is essential if SOE reporting is to be a practical reality.

* Priority refers to related Priority numbers in Tables 2A-D

CHAPTER 4 - TOWARDS A COMPREHENSIVE MONITORING PROGRAM

A comprehensive or "ideal" surface water monitoring program, provides timely and complete information to all clients in a format and with the degree of interpretation that meets all the client and public needs.

In preparation for the tasks to be undertaken in ***Phase II*** of the Committee's assignment, ie. the detailed examination and rationalization of each major surface water monitoring program, the Committee examined the potential components of an "ideal" Ontario network.

Table 4 identifies and describes the four principle parts of a comprehensive surveillance and monitoring network, illustrates their applications and lists some current monitoring programs serving these purposes.

To assist in the future assessment of the monitoring programs, the Surface Water Review Committee developed a matrix (Table 5) that related critical environmental stressors to their potential impact on aquatic communities, human health and a range of water uses. When establishing or reviewing any given station in the monitoring network, appropriate consideration should be given to selecting parameters that will monitor known or anticipated stressors that have high (H) or medium (M) ecological impacts or have similar implications to existing or potential water uses.

The Committee also outlined the general geographic extent of concerns related to known major environmental stressors. Table 6 identifies the occurrence of stressors in each of the Great Lakes and their drainage basins, the Great Lakes connecting channels and their drainage basins and the major basins draining those parts of Ontario outside the Great Lakes Basin. From this table, it is apparent that while some stressors are of concern on a lake or basin-wide scale, the majority of concerns are on a local basis, indicating that, in monitoring station design, understanding of local conditions and the potential for the occurrence of stressors are fundamentally important.

TABLE 4 COMPONENTS OF A COMPREHENSIVE SURVEILLANCE AND MONITORING NETWORK FOR ONTARIO SURFACE WATERS

Program Type	Description	Applications	Current Activities
REFERENCE/ BASELINE SURVEILLANCE	- Limited number of stations on inland lakes, rivers wetlands, and areas of the nearshore Great Lakes and connecting channels that are relatively unaffected by human activity - Physical, chemical and biological monitoring of water and sediments - Characteristic of different areas of the Province - Long-term sampling commitment - Stringent QA/QC on all aspects of the program (sampling, analysis, data management and interpretation)	- Identifying target ("natural") conditions - Assessing natural fluctuations/cycles - Identifying emerging issues - Setting policy, PWQO, water quality indices, etc. - Research (cause-effect relationships, etc.) - State of the Environment reporting	- Provincial Water Quality Monitoring Network (some stations) - Great Lakes Long Term Sensing Sites - APIOS - Lake Sensitivity - Sudbury Extensive and Intensive Lakes (some sites)
GENERAL AMBIENT CONDITION INVESTIGATIONS AND MONITORING	- Widespread chemical, physical and biological sampling program of water, sediment and biota in rivers and streams, inland lakes, nearshore Great Lakes and connecting channels influenced or likely to be influenced by development - Water quantity (flow) measurement in all significant basins - Core group of analyses across the Province with additional types of analyses dictated by local requirements.	- Assessing current conditions - Application of Surface Water Management policies (e.g. compliance with PWQO) - Assessment of expansion and development proposals - Assessing/permitting water takings - Modelling and extrapolation - Identifying spatial and temporal trends - Assessing general benefits of controls/regulations - Identifying emerging issues - Public requests for location-specific information - State of the Environment reporting	- Provincial Water Quality Monitoring Network - Water Quantity Network - Great Lakes Screening Level Investigations Great Lakes Long Term Sensing - Great Lakes RAPs Support - Drinking Water Surveillance Program - Recreational Lakes Programs - Cottager's Self Help Programs - Spring Phosphorus Programs - Muskoka Lakes Study
COMPLIANCE MONITORING	- Chemical, physical and/or biological monitoring of regulated discharges to surface water	- Assessing compliance with Control Orders and other regulatory instruments - Identifying additional control requirements - State of the Environment reporting - reporting on the effectiveness of abatement programs	- Certificate of Approval Compliance Assessment
EFFECTIVENESS MONITORING	- Chemical, physical and biological monitoring designed to directly assess the impact of a management action on the receiver in the immediate vicinity of the source and throughout the zone of potential impact	- Evaluating direct environment benefits of controls and regulations - Identifying the need for additional controls - Investigation and enforcement - State of the Environment reporting	- Lake Simcoe Environmental Management Study - Sudbury Extensive and Intensive Lakes - APIOS - Lake Sensitivity - Clean Up Rural Beaches - Long Range Transport (Chemical and Biological Programs) - Agricultural Pilot Watershed Study - Great Lakes RAPs Support

TABLE 5 CRITICAL ENVIRONMENTAL STRESSORS AND POTENTIAL FOR IMPACT ON ECOLOGICAL FACTORS AND WATER USES

	ECOLOGICAL IMPACTS						USES					
STRESSORS	Productivity	Biodiversity	Biomass	Habitat Modification	Species Competition	Human Health	Water Supply	Recreation	Waste Disposal	Transport	Energy Generation	Fisheries
Toxic Substances	H	H	H	L	H	M / H	H	M	L	L	L	H
Persistent Bioaccumulative Toxics	L	L	L	L	L	H	L	L / H	L	L	L	H
Nutrients	H	H	H	M	M / H	L	M	H	L	L	L	M
Physical Substances	H	H	H	H	H	L	M	M / H	M	L	L	H
Bacteria and Virus	L	L	L	L	L	H	H	H	L	L	L	L
Exotic Species	H	H	H	H	H	L	L	M	L	L	L	H
Flow Alteration	H	H	H	H	M	L	H	H	H	H	H	H
Physical Alterations (Habitat)	H	H	H	H	M	L	L	M	L	L	M	M
Resource Depletion	H	M	H	H	L	M	L	H	L	L	L	H

TABLE 6 GEOGRAPHICAL REFERENCE FOR ENVIRONMENTAL STRESSORS / ISSUES

STRESSORS	Lake Ontario/ St. Lawrence	Lake Erie	Lake Superior	Lake Huron/ Georgian Bay	St. Clair/ Detroit River Corridor	Niagara River	St. Mary's River	James/ Hudson Bay	Nelson River	Ottawa River
Toxic Substances	L / Y	L / Y	L / Y	L / Y	Y / Y	Y / Y	L / N	L	L	L / Y
Persistent Bioaccumulative Toxics	Y / Y	Y / Y	Y / Y	Y / Y	Y / Y	Y / Y	Y / Y	Y	Y	Y / Y
Nutrients	L / Y	Y / Y	L / L	L / Y	N / Y	N / Y	N / L	L	L	L / L
Physical Substances	L / Y	L / Y	L / L	L / L	N / L	N / L	L / L	L	L	L / L
Bacteria and Virus	L / Y	L / Y	L / L	L / L	L / L	L / Y	L / L	L	L	L / L
Exotic Species	Y / Y	Y / Y	Y / Y	Y / Y	Y / Y	Y / Y	Y / Y	?	?	L / ?
Flow Alteration	Y / Y	N / Y	N / Y	N / Y	N / Y	N / Y	N / Y	Y	Y	Y / Y
Physical Alterations	L / L	L / L	L / L	L / L	L / L	L / L	L / L	?	L	L / L
Resource Depletion	Y / Y	Y / Y	L / L	Y / Y	Y / Y	Y / Y	L / L	?	?	Y / Y

waterbody / watershed : L - localized
Y - throughout
N - not an issue

CHAPTER 5 - OPERATIONS REVIEW - COMMITTEE POSITIONS

The following committee positions are presented as background to the recommendations on sample collection, analysis, data management, reporting and planning, that follow in Chapter 6.

5.1 Harmonization

• As the demand for information about the environment increases, the resources required to collect and analyze samples, manage and evaluate data and report are diminishing. Efficiencies must be achieved if an acceptable level of service is to be maintained. Fundamental means of becoming more efficient include the elimination of duplication and establishment of new cooperation in areas of common interest. Such cooperation or "harmonization" of effort has been well demonstrated in such diverse programs as RAPs, LSEMS and APIOS.

• Many groups in the MOEE and many more agencies, institutions and citizens' groups are involved in the collection of information on Ontario's environment. A list containing such activities has been assembled by EMRB and should be employed to identify areas where future cooperative undertakings should be considered.

• The EMRB must take the lead in identifying areas for possible harmonization or improved cooperation and initiate or oversee efforts that will lead to new sharing and cooperation. For example, MNR has instituted an ecosystem level monitoring program associated with SPOF (Stratefic Plan for Ontario Fisheries); harmonization of MOEE and MNR activities has potential benefits.

• Harmonization may be achieved in the various components of monitoring programs as described in the following committee positions:

•• Harmonization of Sample Collection and Analysis

- seek out groups or agencies that are willing to undertake sample collections for MOEE in exchange for specialized services, such as sample analyses, specialized interpretation

- reduce sample collection costs by acquiring appropriate information from other programs, offer own information or specialized services in exchange.

- future investigations are needed with other agencies such as Environment Canada, MNR or Ontario Hydro to examine shared use of sampling vessels in the Great Lakes; however, vessels are designed for unique applications and are not exchangeable without major modifications.

- encourage and support the Laboratory Services Branch's initiative to evaluate the role and cost-effectiveness of MOEE analytical laboratories in relation to other laboratories.

•• Harmonization of Data Management

- most existing data management systems in surface water (eg. SIS) are archaic and are a major reason for inefficiency in data analysis and reporting

- institute a common method (e.g. georeferencing) of identifying samples that would more easily permit the integration of information bases

- effective relational database management can satisfy all data management needs

- data management support services should be an integral part of scientific interpretation and reporting; physical proximity is important to improved efficiency

•• Harmonization of Reporting

- under some circumstances joint reporting with other agencies (e.g. MNR, Environment Canada) may be beneficial, consider public review before release

- multi-media reports identifying issue/cause/remedial actions are most informative and valuable to senior management and the public

- MOEE requires a new focus for reporting to the public

- need a broader range of reports to meet client needs:
  i) verified data reports
  ii) summary reports
  iii) interpreted reports
  iv) scientific papers

•• Harmonization of Planning

- establish inter-disciplinary project or task teams that plan and implement integrated (chemical, physical and biological, quality and quantity) sample collection, data management, interpretation and reporting

- maintain communication and good rapport amongst groups and agencies engaged in monitoring

- EMRB should develop and maintain a compendium of provincial and federal monitoring programs, encourage the routine sharing of monitoring program planning information.

5.2 Modernization

• Advanced technology related to aquatic environmental assessment can substantially influence water monitoring procedures and costs. The MOEE must become more aware of the latest advances and determine their potential for application to internal programs. Practical cost-effective advances must be applied that improve the ability to collect and analyze samples, store and manipulate data, interpret and report more quickly, reliably and at competitive cost. To achieve modernization:

•• EMRB and STB must gather information and promote the application of technological and intellectual advances with application to monitoring programs. While program managers are in the best position to take the lead, task groups should be established to evaluate and test promising new methods.

•• Research funds must be dedicated so that promising advances can be tested and, where necessary, modified for practical application by MOEE.

• Modernization to be considered for surface water monitoring programs are more specifically described below under the main components of monitoring:

•• Modernization of Sample Collection and Analysis

- The existing and potential applications and costs of satellite technology must be assessed to determine recent advances in this technology's ability to collect water quality data.

- The application of existing satellite imagery must be further assessed for defining the impact of land use, etc. on water quality, its value in interpreting spatial and temporal trends and setting development guidelines.

- Electronic probes and on-site analytical and test procedures (eg. immuno-assay, microtox-assay) potentially can quickly and reliably assess water quality conditions and should be considered as screening tools.

- Telemetering of real-time data can provide the data needed for special case compliance monitoring, OD's use for this needs to be assessed.

•• Modernization of Data Storage and Management

Data Management has been identified as a very critical limitation in many of the MOEE monitoring programs. A modernized data storage and management system would include the following:

- ▸ data quality objectives
- ▸ seamless integration of field and laboratory data
- ▸ user-friendly, rapid turnaround
- ▸ widely accessible to all legitimate users
- ▸ local, inexpensive data processing facilities
- ▸ ability to integrate various data bases
- ▸ quality assurance procedures
- ▸ comprehensive, on-site system support

•• Modernization of Reporting

- Traditionally, the results of monitoring programs have been communicated through printed reports. This process has often proven to be costly and time consuming. Availability and distribution of reports is limited.

- While there is a continuing need to print some reports, MOEE must consider promoting modern, more efficient, electronic information dissemination through recent and evolving technologies such as computer disks or CD-ROMs, electronic mail and Internet.

5.3 Externalization

• Beyond the benefits that might be achieved through harmonization and modernization, the potential may exist for monitoring-related functions such as sample collection, data storage and sample analyses to be contracted out at improved cost effectiveness.

• Review should be undertaken to evaluate the relative costs of these functions internally and externally and determine if programs might benefit from externalization. The current review by the Laboratory Services Branch should address issues related to some components of laboratory sample analysis.

• Experience has shown that externalization of surveillance and monitoring functions, including sample collection, sample analysis, interpretation and reporting is generally more costly when compared to an internal operation.

• Benefits may not be exclusively fiscal. Through external sample collection or analysis, a greater amount of staff time could be directed to other critical functions of data evaluation, reporting and planning.

• When considering the externalization of a program or an activity, several factors potentially come into consideration:

- •• costs
- •• loss of flexibility in scheduling
- •• loss of on site adjustments and control (eg. sampling)
- •• significant additional internal cost for essential QA/QC, and contract tendering, management, etc.
- •• timelines of execution

5.4 Commercialization

- In light of declining Provincial resources, there has been a trend to the adoption of user fees where a substantial external demand for Government products or services exist. All information generated by MOEE monitoring programs has an intrinsic value. Some, most notably the larger, Province or region-wide programs or services can have a commercial value.

- Charging for a MOEE product or service should be restricted to those who profit from the product or service.

- At the corporate level, the Ministry or Province must provide guidance on commercialization of products and services (eg. budgetary process, liability, long term viability etc.), identify its range of products and services related to environmental monitoring and determine the markets that may exist. Products may include verified data bases, data summaries and interpreted data (reports).

- Services that may have some commercial value include the renting out of Great Lakes vessels and specialized sampling equipment and consulting by staff with unique knowledge and expertise. Any such examination should be done at the corporate level and include all specialized services such as the mobile air monitoring units, other mobile laboratories, specialized sampling equipment, etc.

- If the MOEE were to engage extensively in commercial sale of its information and services then reciprocal arrangements would have to be made with current and new partners and other data generators who may in turn charge MOEE for their products. Benefits of commercialization would, therefore, become questionable.

- Revenues from commercialization should be directed toward the program that generates them to address deficiencies in that program.

CHAPTER 6 - OPERATIONS REVIEW - RECOMMENDATIONS AND ACTIONS

Using the Committee positions presented in Chapter 5 as background, the results of the many discussions were evaluated and a comprehensive set of recommendations were developed that, if implemented, will improve the efficiency and effectiveness of surface water monitoring. Following a number of general recommendations, specific recommendations and actions are provided for each component of a monitoring program - sample collection, analysis, data management, interpretation and reporting and planning. General directions are also given where possible as to which Division or Branch should be responsible for the implementation of the recommendation.

6.1 General Recommendations:

- develop a unifying monitoring framework for stream, inland lake and Great Lakes monitoring with central co-ordination
- clarify roles of the Federal Government vs. Province
- establish relative priorities and rationalize resource allocations between internal research monitoring and operational monitoring needs
- assess potential and benefits of integrating similar monitoring programs in MOEE and MNR (ESSD-OD)
- develop a data management system with integrating linkages and ready designated client access to all data bases (ESSD)
- establish task groups to evaluate and test promising new methods for sample collection and analysis; allocate research funds accordingly

6.2 Sample Collection

Recommendation: **Optimize existing monitoring programs and resource allocations to meet needs of MOEE and other resource agencies (Phase II).**

Action:
- improve coordination and partnerships with federal monitoring agencies, MNR, CA's, municipalities, institutions and public (ESSD, OD)
- clarify roles of ESSD vs. OD in monitoring
- assess cost-effectiveness of privatization (ESSD)
- improve use of statistical survey design
- consider MOEE-MNR resource integration/partnerships (ESSD, OD)
- extend requirement for proponent compliance monitoring and reporting (OD); develop protocols (OD-ESSD)
- evaluate cost effective, efficient new technologies, including telemetering, remote sensing
- assess cost-effectiveness of renting out specialized services and equipment; consider on corporate level

6.3 Sample Analysis

Recommendation: **Review and Optimize sample analysis operations and services**

Action:
- rationalize sample requests and parameters for MOEE sample analyses and costs associated with programs, including biological testing and identification (ESSD)
- develop and evaluate use of on-site screening tools including biological testing to focus sample collection and submission, eg. Immuno-Assay Test-Kits (ESSD, OD)
- evaluate and adopt use of state-of-the-art technologies in the field and laboratory (ESSD, OD)
- routinely review requests and requirements and adjust to client needs (ESSD)

(* - for sample submissions to MOEE labs, 1990-1994, see Appendix C)

6.4 Data Management

Recommendation: **Improve data management and data analysis operations and services.**

Action:
- consider/assess privatization of data management services (ESSD)
- move from the current mainframe SIS data storage system to state-of-the-art local data management systems
- develop data base integration access linkages (ESSD)
- allow ready access to all data bases by designated clients (ESSD, OD)
- strengthen data analysis and reporting support services for internal programs (ESSD)
- ensure data analysis resources/capability meets data collection efforts in all programs (see Primary Deficiency Table - Appendix D)
- install data analysis management support services as an integral part of the scientific operations

6.5 Reporting

Recommendation: **Develop and implement a reporting framework to meet the designated client needs.**

Action:
- assess client needs for monitoring data, interpretation and reports (ESSD, OD)
- design a corporate reporting framework (ESSD-OD):
  - consider new focus for public, public review
  - develop guidelines for public reports vs. scientific publications (ESSD, PACB)
  - clarify role of PAC Branch vs. scientists in reporting to the public (ESSD, OD)
  - explore alternatives to printed reports
  - client and science needs are: verified data reports, summaries, interpreted reports (issue, cause, remediation), scientific papers
- establish accountability for reporting according to approved framework
- improve communication linkages between ESSD and OD programs in reporting (ESSD, OD)

6.6 Planning

Recommendation: **Revise the annual and longterm planning process to ensure client needs are met.**

Action:
- conduct annual planning cycle to ensure regular consultation with identified priority clients, especially OD (ESSD)
- develop a 5-year planning framework to identify new information needs (ESSD)
- evaluate basic goals and accomplishments of each program annually (ESSD, OD)
- ensure senior management input to annual planning cycle; get confirmation of priorities (ESSD, OD)
- co-ordinate internally with complementary monitoring programs, with emphasis on multi-media assessments (ESSD, OD)
- coordinate with federal and provincial agencies involved in complementary monitoring (ESSD)
- set up electronic information exchange system between ESSD / OD and other clients

CHAPTER 7 - RESOURCE SUMMARIES AND RECOMMENDED PROGRAM ADJUSTMENTS

In addition to the foregoing general recommendations that could apply to all surface water monitoring programs, the Committee has identified issues, called adjustments, that apply to specific programs. In some cases, the adjustments include a recommendation to re-allocate resources to programs or functions that have been substantially deteriorated as the result of resource reductions in recent years. While the reallocations identified are all additions, the Committee is not necessarily seeding new money. By adjusting the total pool of resources currently allocated to MOEE monitoring and surveillance-type programs through down-scaling or eliminating some programs, the proposed re-allocations could likely be accommodated. It was not within the Committee's terms of reference to recommend reducing or eliminating specific programs.

In examining the recommendations, it is evident clear that nearly all recommendations for adjustment in stream and inland lake monitoring relate to the strengthening of services for MOEE's delivery arm, Operations Division's abatement. Enhancements in Great Lakes monitoring activities relate mainly to meeting the provincial commitments under the new Canada-Ontario Agreement respecting the Great Lakes Basin Ecosystem and maintaining a minimal effort in seeking out undiscovered new or emerging problems.

7.1 Resource Summary - Stream Water Quality/Quantity Monitoring

BRANCH / DIVISION	PROGRAM CODE*	PROGRAM	PERSON YEARS [1]	ODOE $K [2]
EMRB / ESSD	4 / 5 / 6	Provincial Water Quality Monitoring Network (PWQMN)	3.5	86
	7	Streamflow Monitoring Network (cost-share)	0.5	106
TOTAL EMRB			4.0	192
STB / ESSD	1	Agricultural Pilot Watershed Studies	0.2	25
	2	Cleanup Rural Beaches Program (CURBS)	1.0	2 + 6M (cap)
	3	Long Range Air Transport - Bio. Effects [3] - streams	1.2	19
	4	Long Range Air Transport - Chem. Effects - streams	3.2	133
	5	Occurrence of Mercury in the Environment - streams	0.8	35
	7	Lake Simcoe Environ. Mgt. Strategy - Tribs.	1.2	40
TOTAL STB			7.6	254 + 6M (cap)
PDB / ESSD	2	Heritage Estate Stormwater Mgt. Study	0.6	50
SDB / ESSD	1	Rouge Watershed Sediment Study	0.1	5
OPS DIV	5	English - Wabigoon Mercury Monitoring	-	-
	12	PWQMN Participation (sample collection)	1.0	18
	11	C of A Compliance Assessment	1.8	30
TOTAL OPS. DIV.			2.8	48

TOTAL STREAM MONITORING	**15.3**	**549 + 6M (cap)**

(1) includes only PY's dedicated by ESSD or OD; does not include partnership contributions
(2) includes only ODOE budgets allocated by MOEE or OD; does not include LSB costs or partnership contributions
(3) included in the Biomonitoring Review
* refer to Program Inventory, Table 1 (e.g. EMRB-4)

7.1 Stream Monitoring

Existing river and stream monitoring programs in EMRB comprise mainly the Provincial Water Quality Monitoring Network (PWQMN) and the cost shared Streamflow Network, providing specific water quality trend information and effectiveness monitoring. The majority of resources for stream monitoring are housed in ESSD/STB, dedicated to research monitoring to study the effects of long-range air transport and deposition (including acid rain, the study of mercury in the environment and LSEMS and CURBS), special programs for Lake Simcoe and agriculture runoff management.

Recommended Adjustments	Adjustment Required
1. redesign and optimize the provincial stream water quality network (PWQMN) to include: - a fixed station network for long term reference - a periodic network (5 yr) to meet special commitments (eg. COA) - a variable network (annual) to meet regional regulatory and planning needs - enhanced database analysis and reporting capability to meet OD needs for review and approval functions, including pollution control and land use development	**
2. rationalize and redesign the MOEE needs for the streamflow monitoring network with the Federal Gov., MNR, Ontario Hydro (currently ongoing) to include: - a long term index station network as base for extrapolation modelling - a short term network for OD and multiagency planning (eg. development) needs	**
3. senior management is asked to review the resource allocations for STB research monitoring, e.g. and EMRB and OD operational monitoring shortfalls.	**
4. in future, re-establish capability in ESSD to assist OD in special investigations/monitoring studies (eg. investigation of spills, waste assimilation, watershed planning, etc.)	**

7.2 Resource Summary - Inland Lake Monitoring

BRANCH / DIVISION	PROGRAM CODE*	PROGRAM	PERSON YEARS [1]	ODOE $K [2]
STB / ESSD	5	Occurrence of Mercury in the Environment - lakes	0.7	30
	6	Muskoka/Joseph/Rosseau Lakes Mgt. with MNR	1.7	40
	7	Lake Simcoe Environmental Mgt. Strategy Implementation (lakes)	1.4	100
	3	Long Range Air Transport - Bio. Effects [3] - lakes	4.8	76
	4	Long Range Air Transport - Chem. Effects - lakes	1.4	57
TOTAL STB			10.2	303
OPS DIV	1	Recreational Lakes Monitoring Program (East)	1.0	10
	2, 8	Cottage SELF-HELP Program (East + Mid. Ontario)	1.3	8.5
	3, 10	Spring Phosphorus Monitoring (North + Mid. Ontario)	0.4	3
	-	APIOS Lake Sensitivity Studies (North) [4]	-	-
	6	Sudbury Extensive Lakes (45) Monitoring	0.3	8
	7	Sudbury Intensive Lakes (6) Monitoring	0.9	30
TOTAL OPS DIV			3.9	59.5

TOTAL INLAND LAKE MONITORING	**14.2**	**363**

(1) includes only PY's dedicated by ESSD or OD; does not include partnership contributions
(2) includes only ODOE budgets allocated by MOEE or OD; does not include LSB costs or partnership contributions
(3) also shown in Biomonitoring Review
(4) not funded since 1991
* refer to Program Inventory Table 1 (e.g. STB-5)

7.2 Inland Lake Monitoring

Recommended Adjustment:

Inland lake monitoring is conducted primarily by the ESSD/STB and the Operations Division. STB conducts annual monitoring in cooperation with MNR in Lakes Muskoka, Joseph, Rosseau and Lake Simcoe, and monitors the effects of long-range air transport including acid rain on several lakes around the Dorset area. Operations Division monitors the effects of Sudbury emissions around Sudbury lakes and uses limited resources and cottagers to examine recreational lakes under development pressure.

	Ajustment Required
1. produce and release joint MOEE-MNR management strategies for Lakes Muskoka, Joseph and Rosseau similar to LSEMS •• reduce monitoring activity to periodic assessment •• establish timelines	**
2. continue and promote wider application of the Cottage SELF-HELP programs in Eastern and Mid-Ontario, consider for Northern Region (OD)	
3. strengthen Regional recreational lakes monitoring programs to meet lake development pressures in Eastern, Mid-Ontario and North Ontario (OD)	**
4. review monitoring for effectiveness of Countdown Acid Rain and local emission reduction programs in impacted lakes (ESSD, OD) •• set frequencies and timelines to reflect priority of issue	**
5. senior management is asked to evaluate priority and resource allocation in STB research monitoring and OD needs for operational monitoring •• consider monitoring to be directed toward OD lakeshore development pressures and need for remediation technologies	
6. in future, establish resources for development and implementation of a coordinated framework for inland lake monitoring: •• maintain and update lakeshore development capacities on a watershed basis •• address information gaps for local OD decision making •• set up 5 year planning cycle with OD, MNR and MMA to identify and meet local and regional pressures •• meet public demand for information related to recreational use •• evaluate need for chem/biol/ monitoring of wetlands related to development	**

BRANCH / DIVISION	PROGRAM CODE*	PROGRAM	PERSON YEARS [1]	ODOE $K [2]
EMRB / ESSD	1	Great Lakes Screening Investigations Outside RAP Areas - Emerging Problems	1.0	90
	2	Great Lakes RAP Investigations	3.5	63 + 78 (PDB)
	3	Great Lakes Longterm Sensing	1.0	80
	9	Great Lakes Marine/Field Operations	6.0 *	250
	10	Water Intakes Monitoring Program	1.0	9
	8	Drinking Water Surveillance Program	(2.8)	(122)
TOTAL EMRB (PDB)			12.5	492 + 78 (PDB)
STB / ESSD	8	Great Lakes and Connecting Channels Chemical Transport and Spills Modelling	(5)	(50)
OD	13	Participation in RAP Investigations	1.5	50

TOTAL GREAT LAKES MONITORING	**14**	**620**

( ) - primary purpose not as Great Lakes monitoring
* - add 4 to 6 summer students
(1) includes only PY's dedicated by ESSD or OD; does not include partnership contributions
(2) includes only ODOE budgets allocated by MOEE or OD; does not include LSB costs or partnership contributions
* refer to Program Inventory Table 1 (e.g. EMRB-1)

7.3 Great Lakes Monitoring

Great Lakes monitoring programs are conducted mainly in the Great Lakes Areas of Concern (RAP Areas) to assist in the remedial measures assessment and delisting process. Limited investigations are also carried out to provide screening of undetected or emerging problems, i.e. harbours and embayments outside RAP areas and to provide long-term sensing at selected sites throughout the four lakes on a 4-year cycle.

Recommended Adjustments:

		Adjustment Required
1.	work closely with PDB, Federal Gov't, MNR and OMAFRA to develop integrated monitoring programs to meet COA commitments; current staff and $ resources in EMRB are inadequate to meet monitoring needs for:	
	•• RAP areas delisting	**
	•• Lake Ontario, Erie, Superior/Nipigon Lakewide Management Plans (LaMPs)	**
	•• Field and Marine Operations	**
2.	continue Screening Investigations in areas and issues outside RAP areas to identify existing and emerging issues/problems requiring abatement	
	•• clarify and establish roles and responsibilities of EMRB and OD in investigations and abatement	
3.	continue cyclical Long Term Sensing Site monitoring in support of COA (LaMPs) and SOER	
	•• integrate Drinking Water Monitoring Data (raw)	
	•• integrate water intake biomonitoring data	
	•• integrate with MNR and Federal Gov't activities where possible	
4.	in future, re-establish periodic nearshore monitoring program as complement to federal open-lake monitoring, essential for the understanding of the nearshore environment	**

APPENDICES

APPENDIX A.1 : Surface Water Review Committee - Terms of Reference

Using the goals and ofjectives of monitoring and reporting as the focus, the program review process will assess existing ESSD and OD monitoring programs and their tie-in with other monitoring efforts, and determine/recommend future directions for monitoring in the province. This will be accomplished by:

- reviewing existing monitoring activities to identify current monitoring initiatives, client needs, data and reporting requirements
- identifying monitoring gaps and needs, including resource impacts
- providing options and giving recommendations for future monitoring directions, addressing the need for integration of monitoring efforts, data optimization, partnerships and effective reporting

APPENDIX A.2 : Goals and Objectives of Monitoring/Reporting

Goal of monitoring/reporting

To monitor, assess and report on the state of the environment in support of informed decision-making that leads towards the restoration and maintenance of the province's ecosystems.

Objectives to achieve monitoring/reporting goal

a) The Ministry will focus its monitoring and reporting efforts to assess the state of Ontario's environment, while recognizing the need for ongoing compliance monitoring.

b) The Ministry will contribute towards sustainability reporting by integrating reporting on the state of the environment with the broader economic and social issues.

c) The Ministry will provide information on the state of the environment to be used as an integral part of Ministry, and inter-Ministry priority-setting for environmental protection.

d) The Ministry will take a leadership role with other Ontario Ministries and jurisdictions in the development of a truly integrated provincial monitoring and reporting framework.

e) The Ministry will work with the other provinces and the federal government in the development of a national monitoring and reporting system.

APPENDIX B : MOEE Legislative Mandates, Directives and Agreements

- **Legislative Mandate**

The MOEE role in the management of water resources is identified, primarily in three Ontario Statutes, the Ontario Water Resources Act, the Environmental Protection Act and the Environmental Assessment Act. Although the activity of developing and maintaining monitoring networks to assess the condition of the natural environment is not explicitly cited in the acts, there is sufficient instruction to clearly show that, if the MOEE is to successfully fulfil its mandate, a comprehensive understanding of the state of Ontario's environment is essential. Surveillance and monitoring are some means of achieving this understanding. Excerpts from the acts that demonstrate the need for understanding the environment include:

- Ontario Water Resources Act:

"...the Minister has the supervision of all surface waters and groundwaters in Ontario" (Section 29.1)

"The Minister may examine any surface waters or ground waters in Ontario from time to time to determine what, if any, pollution exist and the causes thereof." (Section 29.2)

- Environmental Protection Act:

"No person shall discharge into the natural environment any contaminant ... in an amount concentration or level in excess of that prescribed by the regulations." (Section 6.1)

"When a Director ... is of the opinion that a source of contaminant is discharging into the natural environment any contaminant that constitutes ... an immediate danger to human life, the health of any persons , or to property, the Director may issue a stop order..." (Section 8.1)

" When any person causes or permits the discharge of contaminant into the natural environment, so that land, water property, animal life, plant life or human health or safety is injured, damaged or endangered, the Director may order the person to ... repair...prevent the injury or damage ..." (Section 17)

- Environmental Assessment Act:

" An environmental Assessment submitted to the Minister ... shall consist of ... (ii) the effects that will be caused or might reasonably be expected to the environment ... (iii) the actions necessary ... to prevent change, mitigate or remedy the effects upon ... the environment." (Section 5)

" The Minister, for the purposes of the administration and enforcement of this Act and the regulation may, ... (b) conduct studies of the quality of the environment, ... (e) gather, publish and disseminate information with respect to the environment ..." (Section 31)

- **MOEE Directives and Operational Policies**

The Ministry of the Environment and Energy through such pronouncements as the Environmental Bill of Rights, the Ministry's Mission Statement and Statement of Environmental Values clearly convey the need to understand the environment. Similarly, "Water Management" is the principle set of MOEE policies related to the protection and restoration of Ontario's surface and ground water, quality and quantity. As in the statutes, there is no explicit requirement for the MOEE to undertake or oversee the undertaking of surveillance and monitoring programs, but, in order to meet its principles and carry out the policies, a comprehensive and up-to-date understanding of aquatic environmental conditions is essential. Policy examples from "Water Management" which clearly indicate the need for MOEE to understand the state of Ontario's surface water resources in order to properly manage these resources include:

In areas which have water quality better than the Provincial Water Quality Objectives, water quality shall be maintained at or above the Objectives.
(Surface Water Quality Policy 1)

Water quality which presently does not meet the Provincial Water Quality Objectives shall not be degraded further and all practical measures shall be taken to upgrade the water quality to the Objectives.
(Surface Water Quality Policy 2)

- **Agreements**

Ontario has developed formal and informal environmental management agreements with many other agencies and groups inside and outside Ontario. Many of these agreements do require environmental monitoring for the successful identification and specification of remediation needs and confirmation of the environmental benefits of remediation:

- - <u>International and Federal Agreements:</u>

- Canada-Ontario Agreement (COA), 1994 (RAPs, LAMPS)
- Great Lakes Water Quality Agreement (various annexes including a annex (11) specifically requiring surveillance and monitoring activities
- Canada-Ontario Hydrometric Agreement (Streamflow monitoring)
- Niagara River Toxics Management Plan (50% reduction target)
- Ontario-Michigan Accord (cooperative water quality management)

- Countdown Acid Rain '94 (benefits of reductions in acid-causing emissions)
- Environment Canada Environmental Effects Monitoring (MOEE role to be determined)
- CCME (Harmonization of federal and provincial activities)
- Federal-Provincial Trent-Severn Waterway Agreement

●● Agreements with Other Provincial Ministries and Agencies:

- LSEMS (MOEE,MNR, Lake Simcoe C.A., municipalities - pollution control)
- Foster-Giles (MOEE-MNR issues of mutual interest)
- MOEE-MNR Cabinet Submission of Zebra Mussel management
- Septic Tank Installation Inspection (delegated in many parts of Ontario to Medical Officers of Health)
- MOEE-MNR-Laurentian University Agreement
- MOEE-MNR Muskoka Lakes Studies Agreement

●● Undertakings Involving the Private Sector, Municipalities and Ontario Citizens:

- Cottagers' Self Help Program
- Cottage Pollution Control Program
- CURBS (non-point source pollution control demonstration projects)
- MISA (control of toxic substances from municipal sewage treatment plants and industrial point sources)

APPENDIX C : MOEE LABORATORY LOADS

Tests / Samples		1990/91	1991/92	1992/93	1993/94	1994/95
LSB Reported Tests	Great Lakes	159944	145030	113641	84821	-
	PWQMN	100694	105079	76053	85557	-
	Surface Water	123926	93506	95047	80314	-
	Total Tests	**384564**	**343615**	**284741**	**250692**	-
Great Lakes Samples	Water - Phys/Nut	3050	1960	2025	1600	-
	Water - Metals	1135	1022	1037	832	-
	Water - Organics	543	374	515	138	-
	Sediment - Phys/Nut	743	1052	418	340	-
	Sediment - Organics	645	797	425	220	-
	Biological - Metals	401	293	222	39	-
	Biological - Organics	411	339	128	135	-
	Total Samples/Tests (est.)	**6931**	**5837**	**4770**	**3304/65137**	-
PWQMN Tests	Central	100694	105079	76053	85557	-
	Thunder Bay/London	29030	30181	52739	31496	-
	Total Tests	**129724**	**135260**	**128792**	**117053**	-
CURBS Samples	Chemistry - Central	-	2500	3300	3600	3600
	Chemistry - London/Kingston	-	4850	6520	4200	4350
	Bacti - Central	-	2500	3000	2500	2000
	Bacti - London/Kingston	-	6300	4200	3900	3475
	Bacti - Health	-	1266	3080	2131	1780
	Total Samples/Tests (Central)	-	**17416**	**20100**	**16331/50700**	**15205**
Dorset Tests	LSEMS	-	-	11000	18000	27500
	APIOS	-	-	65000	50000	43000
	Muskoka Lakes	-	-	-	12000	8500
	Total Tests	-	-	**76000**	**80000**	**79000**

Est. Total Costs (GL., PWQMN, CURB, LSEMS, APIOS, Muskoka) : ODOE $711 K, PY 31

APPENDIX D : PRIMARY DEFICIENCIES

Lead Group		Sample Collection	Sample Analysis	Data Management	Reporting	Planning
RIVERS / STREAMS						
PWQMN	EMRB			✓	✓	✓
Streamflow Network	EMRB			✓		✓
Ag. Pilot Watersheds	STB			✓	✓	
CURBS	STB			✓	✓	
Long Range Air Transport	STB				✓	
Hg in the Environment	STB	✓	✓	✓	✓	✓
LSEMS (Tribs)	STB	✓			✓	
Rouge. R. Sediment Study	SDB					
English-Wabigoon Hg	NOR					
BIOMAP	SWR					✓
C of A Compliance Assm't	Regions			✓	✓	
INLAND LAKES						
Hg in the Environment	STB		✓	✓	✓	
Muskoka Lakes Mgmt.	STB				✓	
LSEMS	STB	✓	✓			
Recreational Lakes	ER					✓
Cottagers Self-Help	ER & MOR					✓
Spring Phosphorus	NR & MOR					✓
APIOS Lake Sensitivity	NOR					
Sudbury Extensive Lakes	MOR					✓
Sudbury Intensive Lakes	MOR					✓
APIOS Lake Sensitivity	STB	✓				
GREAT LAKES						
GL Screening Investigation	EMRB			✓	✓	
GL Rap Investigations	EMRB			✓		
GL Long Term Sensing	EMRB			✓		✓
GL Marine/Field Ops.	EMRB	✓				
Water Intake Mom. Pgm.	EMRB					
DWSP	EMRB					
GL Chem Transport/Spills	STB					

MONITORING REVIEW

GROUNDWATER

NOVEMBER 1994

GROUNDWATER MONITORING PROGRAM

Third Draft

Toronto, November 24, 1994

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APPENDIX I GROUNDWATER QUESTIONNAIRES

EXECUTIVE SUMMARY

The Groundwater Monitoring Review Group was formed to review existing Ministry of the Environment and Energy (MOEE) monitoring programs and their tie-in with other monitoring efforts conducted by public and private agencies. This review has involved the identification of current monitoring initiatives, clients and their needs, data gathering and reporting requirements, monitoring gaps and needs, and the provision of options and recommendations on future monitoring directions.

The review identified two federal agencies and nine provincial agencies all involved to one degree or another in groundwater monitoring. Also recognized is the involvement of Ontario's academic and consulting communities. These various agencies and organizations actively acquire vast quantities of reliable data regarding the state of Ontario's groundwater resources through a multitude of direct and indirect monitoring efforts.

Most groundwater information is currently being collected through site specific assessments conducted by professional environmental consultants. These assessments are normally completed as supporting documentation for various approval applications and in support of regulatory compliance requirements. Numerous federal and provincial statutes, regulations and policies deal with groundwater resources and provide the legal umbrella under which most groundwater information is collected.

Provincial initiatives aimed at monitoring the state of Ontario's principal aquifers while quite active in the late 1970's and early 1980's are currently very limited. Only a few examples of ambient groundwater monitoring exist today. If not for funding from outside agencies, even these few monitoring programs would not be able to continue. Fiscal constraint within the provincial government continues to threaten even the most basic and essential of our groundwater monitoring programs: the Water Well Information System (WWIS).

The program review has affirmed the need to reinstate the provincial groundwater monitoring initiatives. The review has defined the need for a provincial aquifer mapping program and a long-term aquifer monitoring program. Key to these programs is a commitment to the maintenance of the existing WWIS database. Also required is the development of a new provincial database to manage the vast amount of groundwater information currently being generated through various programs across the province.

Through enhanced, coordinated efforts involving all of the various agencies dealing with Ontario's groundwater resources, a

truly meaningful groundwater monitoring program can be established. Long-term ambient monitoring of our principal aquifers, coupled with effective management of currently available groundwater data, will enable us to provide useful assessment of the state of the resource. Such assessment would increase public confidence in our ability to properly manage and protect this valuable resource.

The purpose of this report is to review how groundwater is currently being monitored across Ontario, to identify our partners in groundwater monitoring, to highlight areas of duplication or need, and to make recommendations for an improved, coordinated groundwater monitoring program. In addition, the report provides an overview of the significance of Ontario's groundwater resources, describes groundwater occurrence in the province, and delineates priority environmental issues.

RECOMMENDATIONS

A. GROUNDWATER RESOURCES

- The Aquifer Mapping Program should be resumed to provide proper management and protection of Ontario's groundwater resources, including the establishment of an effective long-term groundwater monitoring program. As part of deliberation to revive the Program, a priority list of aquifers and watersheds should be established. The objectives of the Aquifer Mapping Program should be:

  - the establishment of criteria to define principal aquifers in Ontario;

  - the identification of principal aquifers;

  - the ranking the aquifers according to their susceptibility to contamination; and

  - the identification of the interaction between surface and groundwater flow systems **(see Long-term Ambient Monitoring/Aquifer Mapping)**.

- Groundwater protection should be enhanced by focusing on the prevention of groundwater contamination, identifying and controlling regulated source discharges, implementing "Best Management Practices" for non-point sources of pollution, developing numerical limits for allowable impacts, and protecting sensitive areas **(see Groundwater Contamination)**.

B. GROUNDWATER MONITORING

- It is recommended that MOEE establish a long-term groundwater monitoring network. The objectives of the network should be:

  - the establishment of observation wells to provide groundwater quality and water level variations data;

  - the establishment of sampling protocol and quality assurance program to ensure consistent and reliable data;

- the development of a database management system linked to other related databases;

- the incorporation of existing high quality data into the database;

- the provision of "snapshots" of existing groundwater quality and groundwater level variations to identify potential problems; and

- the maintenance of the database to assist in the formulation of groundwater protection policy **(see Long-term Ambient Monitoring/Groundwater Monitoring Network).**

- Efforts should be made to eliminate the backlog of water well records and institute a program to deal with the new records. As part of these efforts, the geographic coordinates and elevations of all newly constructed wells should be identified. This can be accomplished either by establishing a water well permit fee to cover costs or by requiring well drillers to identify the elevations and location coordinates of new wells through the use of GPS equipment **(see Compliance and Investigative Monitoring and Land Use Reviews/MOEE Water Well Program).**

- To make better use of the groundwater water quality data, collected through various programs, it should be a requirement to take readings of the geographic coordinates of all water samples taken in the field **(see Compliance and Investigative Monitoring and Land Use Planning Reviews).**

C. DATABASE MANAGEMENT

- Data collected through the Drinking Water Surveillance Program (currently, 25 municipal systems), audits of municipal groundwater supplies, monitoring of municipal groundwater fields, provision of communal water supplies, and developments on individual private wells are very high in quality. These data should be incorporated into the Groundwater Monitoring Network's database **(see Long-term Ambient Monitoring/Groundwater Monitoring Network).**

- Hydrogeologic information and monitoring data collected as a result of compliance with MOEE's Acts, regulations, policies, and guidelines that are kept on file in various Head and Regional offices should be computerized through a phased-in program **(see Compliance and Investigative Monitoring and Land Use Planning Reviews).**

- In cooperation with our partners, an effort should be made

to assemble and computerize data related to groundwater that have been generated, including:

- the results of bacteriological and chemical analyses conducted by the health units;
- the amounts and locations of road salt applications carried out by MTO and road authorities;
- the results of pesticide tests conducted by OMAFRA;
- the data on fertilizer and pesticide applications in Ontario, which are being assembled by OMAFRA and Statistics Canada;
- the data gathered during watershed planning exercises; and
- the vast quantity of information and hard data generated by Ontario's consulting community **(see Gaps and Needs Related to our Partners in Groundwater Management)**.

D. ENHANCED COOPERATION

- Recognizing the multi-jurisdictional nature of groundwater management in Ontario, the cooperation, consultation, and communication on groundwater with our partners - the federal and provincial agencies, conservation authorities, municipalities, academia, and consulting firms - should be enhanced **(see Gaps and Needs Related to our Partners in Groundwater Management)**.

& MOEE should take the lead role. (not MNR?)

- The cooperation among MOEE staff who deal with groundwater issues should be enhanced through improved communication and consultation, the establishment of an MOEE Standing Committee on Groundwater, and the holding of an annual seminar on groundwater technical and management issues, including monitoring issues **(see Gaps and Needs Related to our Partners in Groundwater Management)**.

INTRODUCTION

1. GENERAL COMMENTS

On February 7, 1994, E. Piché, Director, Environmental Monitoring and Reporting Branch (EMRB), established the Groundwater Monitoring Review Group on the instructions of the Environmental Sciences and Standards Division (ESSD) Management Team. The purpose of the Group was to review existing EMRB monitoring programs and their tie-in with other monitoring efforts conducted by other ESSD Branches and the Operations Division, and determine/recommend future directions for monitoring in the province. This was to be accomplished by:

- identifying existing program clients and client needs;
- reviewing existing MOEE monitoring activities and those of other agencies;
- identifying current monitoring initiatives, data gathering, and reporting requirements;
- identifying monitoring gaps and needs, including resource impacts; and
- providing options and giving recommendations on future monitoring directions that address the need for integration of monitoring efforts, data management and utilization, partnerships, and effective reporting.

Monitoring of groundwater is not an end by itself, rather it is a means to enhance the management and protection of these resources. Through the provision of adequate information and predictive tools, decision-makers and the public are assured that groundwater issues are being appropriately addressed in land and water use planning. Thus, groundwater monitoring is a means to ensure:

- the fair sharing and conservation of available groundwater;

- the protection of groundwater quality through the prevention of future contamination and the abatement of existing sources of impairment; and

- the provision of adequate information and predictive tools to decision-makers and the public thus assuring that groundwater issues are appropriately addressed in land and water use planning.

In attempting to manage the groundwater resources in Ontario, staff are required to answer multitude of questions such as:

- what is the significance of the local groundwater resource?

- how much groundwater is available in my area?

- how much groundwater can be withdrawn without negative effects?

- what is the amount of groundwater recharge?

- what is the optimal balance between different demands on the groundwater resource?

- who owns the groundwater resources?

- what are the main aquifers in an area/watershed and how are they delineated?

- at what depth groundwater is encountered?

- what is the relationship between groundwater and surface water in the watershed?

- does groundwater contamination impact upon surface water including the Great Lakes?

- what are the chemical properties of the different groundwater aquifers?

- what are the seasonal and long-term fluctuation of groundwater quality and quantity?

- what will be the effects of urban development, industrial expansion, agricultural activities, and energy extraction (heat pumps) on groundwater? and

- what are the cost implications of these effects?

To answer the above questions and many other similar questions, there is a need for basic information on groundwater condition across the province. An effective monitoring program ensures

that such information is kept current and available.

The purpose of this report is to review how groundwater is currently being monitored across Ontario, to identify our partners in groundwater monitoring, to highlight areas of duplication or need, and to make recommendations for an improved, coordinated groundwater monitoring program. In addition, the report provides an overview of the significance of Ontario's groundwater resources, describes groundwater occurrence in the province, and delineates priority environmental issues.

2. AN OVERVIEW OF THE SIGNIFICANCE OF ONTARIO'S GROUNDWATER RESOURCE

Groundwater is a valuable resource to the public health and economic well-being of all the people of Ontario. Where available in sufficient quantity, groundwater offers substantial advantages over surface water supplies. These advantages include:

- minimum treatment requirements in most cases;
- the avoidance of long, costly pipelines for municipal supplies;
- temperature and water quality are usually uniform; and
- with proper protection, the supply is dependable.

Over one-half of all municipal water supplies in Ontario are from groundwater sources. The municipal population dependant on groundwater is approximately 1.5 million. In rural settings, an additional 1.3 million people obtain their water supplies from private groundwater sources.

It is estimated that there are over 600,000 water wells in the province with some 12,000 to 20,000 additional wells are reported every year.

Water wells are by far the major source of water supply for farm operations. About 90% of farms make use of groundwater for household purposes (30,000-65,000 m3/day) and about 80% make use of it for livestock watering (210,000 - 240,000 m3/day).

Groundwater is also an important source for irrigation purposes. Approximately 40,250 ha of cropland are being irrigated from surface and groundwater sources. Although irrigation in Ontario requires an enormous amount of water (150,000 - 170,000 m3/day), it is second to that required by livestock. Irrigation water

demand, however, is concentrated in several weeks of the year during critical periods of the growing season when large volumes of water are required for short periods.

With consumer trends to eat healthier food, demand for fish in Ontario is continually rising. An aquacultural industry is expanding in the province to meet increasing consumer demand. While this industry is associated with surface water, groundwater is a major source of water supply for many of these operations.

Groundwater is an important source of water supply for commercial operations. Based on published water well records (1946-1984), about 6000 water wells provide water supplies for commercial operations. These operations include service stations, motels, snow making, car washes, arenas, shopping plazas, laundromats, restaurants, and cold storage sheds, to name a few.

Groundwater is an important source of water supply for industrial operations. Based on the published water well records, approximately 1700 wells provide water supplies to industrial operations. These include thermo- and hydro-electric power generation; milk or food processing plants; industrial cooling; steam boilers; hydrostatic testing of pipelines; mining and ore milling operations; and gravel and crushed stone washing.

Groundwater is used to provide water for non-municipal public supplies. Based on the published well records, over 6000 water wells are being used in the province for public water supply. Schools, hospitals, churches, public washrooms, campgrounds, picnic grounds, and conservation areas all make use of groundwater supplies.

Heat pumps and air conditioning units make use of nearly constant groundwater temperature and their popularity is on the increase in the province. To date, about 25,000 ground source heat pump systems have been installed in Ontario.

One of the most important attributes of groundwater that is often overlooked is its contribution to surface water. In Ontario, groundwater contributes a perennial portion of streamflow throughout the year. Over most of Ontario, the mean annual contribution of groundwater to streamflow is less than 20%. However, in areas where sand and gravel deposits outcrop at the surface, groundwater contribution to streamflow can be up to 60% of the mean annual streamflow. During low flow periods, up to 100% of the flow in some streams consists of groundwater discharge. These facts illustrate the importance of groundwater for the survival of fish and aquatic life in Ontario watercourses.

Based on the above, it is clear that groundwater is a precious resource on which much of Ontario depends for social, health, and

economic well-being.

3. GROUNDWATER OCCURRENCE

Groundwater occurs to varying extent in all geologic materials, and those materials that are capable of yielding sufficient water to water wells are called **aquifers**. Groundwater does not stay underground forever, rather it circulates as part of the hydrologic cycle. Like surface water, groundwater flows toward and eventually discharges into streams, rivers, lakes and the oceans.

When precipitation falls on the land surface, part of the water runs off into the lakes and rivers and some of the water seeps into the soil and percolates down to the aquifers. This latter process is called **recharge**.

The **residence time** of groundwater in the subsurface, i.e., the length of time water spends within the groundwater regime, varies enormously. Water may spend as little as a few days or weeks underground, or as much as 10,000 or more years.

Aquifers in Ontario can be broadly divided into bedrock and overburden aquifers. Overburden aquifers are deposits of sand or gravel which are of sufficient extent and permeability to store and transmit groundwater and are readily recharged by percolating water from the surface. Sand and gravel deposits of varying sizes are distributed throughout the province at various locations. These deposits are mostly small in size and usually yield about 1 litre per second (l/s), which is suitable for most domestic uses.

The largest overburden aquifers in Ontario are the Oak Ridges Aquifer complex located north of Lake Ontario and the Alliston Aquifer complex south of Georgian Bay. Other high capacity aquifers are located near the City of Waterloo and provide large quantities of groundwater to municipal supplies. Hundreds of smaller overburden aquifers are scattered throughout the province and provide groundwater supplies to many municipalities and home owners.

Bedrock aquifers are geologic formations that have relatively high secondary porosity and permeability. It is the joints, bedding planes, fractures and solution channels in the bedrock, if they are wide enough and interconnected, that give the bedrock its high permeability.

Precambrian rocks of the Canadian Shield occur at or close to the surface over about two thirds of the province. The remaining one third of the province is underlain by younger, sedimentary rocks of the Palaeozoic era.

Aquifers found within the Precambrian rocks are highly variable in terms of water yield as they are dependent upon the character of fractures within the rock. While water can usually be found within Precambrian rocks, it is extremely difficult to predict its expected depth or anticipated yield.

Certain Palaeozoic rocks, namely the Cambrian sandstone, the Devonian limestone and dolostone, and the Silurian dolostone have high permeability and, generally, produce large quantities of water. Extensive Palaeozoic aquifers in the province include the dolomite of the Guelph-Amabel Formation, the limestone of the Detroit River Formation and the sandstone of the Nepean Formation.

An examination of the published water well records indicates that with the exception of the South Central area of Ontario, bedrock aquifers are in greater use than overburden aquifers. The examination also indicates that the predominant use of wells is for domestic water supply.

The number of dry wells, as a percentage of total wells reported, is an **indicator** of the availability of aquifers in an area. The published water well records indicate that Kent and Lambton Counties in Southwestern Ontario and Prince Edward County in South Central Ontario are located on overburden deposits and bedrock formations less likely to serve as aquifers.

The majority of wells in Ontario provide high quality water supplies that are suitable for drinking purposes. Some wells, however, yield naturally poor quality water which is unsuitable for human, and sometimes also for livestock consumption.

A large number of wells in Essex County and the Regional Municipalities of Niagara and Haldimand-Norfolk have poor groundwater quality in terms of salt, sulphur and mineral content. The source of these quality problems is directly linked to the mineralization process of groundwater as it flows through the water bearing formations.

4. PRIORITY ENVIRONMENTAL ISSUES

There are a number of major environmental issues facing the management of groundwater in Ontario including groundwater withdrawals, flow alterations, groundwater contamination, global warming and severe droughts.

4.1 Groundwater Withdrawals And Flow Alterations

Groundwater is a renewable resource. To maintain this resource indefinitely, an equilibrium between groundwater recharge and

groundwater discharge and withdrawals must be maintained. The safe yield of an aquifer defines the amount of water which can be removed on a continuous basis without harming the sustained supply. Withdrawals from an aquifer in excess of its safe yield for extended periods of time will deplete the water stored in the aquifer, lower its water table or piezometric surface, could detrimentally affect the yield from wells within the aquifer, and would reduce groundwater contribution to surface waters.

Historically, the management of groundwater quantity has been defined primarily in terms of regulating the withdrawal of water through the Permit to Take Water Program. Despite the overall success of this program, new arguments have appeared in a number of municipalities over the right to bottle groundwater and over the ownership of the groundwater resource. In addition, complaints continue about uncontrolled flowing wells; leaking or release of water from a well or excavation; rising groundwater levels after abandonment of municipal well fields; and groundwater withdrawals affecting streamflows; land subsidies caused by groundwater takings; road, bridge or other construction projects; and drainage works constructed under the Drainage Act.

While much of the impetus for groundwater protection is based on the need to maintain potable drinking water supplies, environmental and ecological considerations are equally important. Communities that depend on groundwater withdrawals can ill afford to have land use changes deplete the groundwater recharge.

Further, most of our streams, rivers, lakes, and wetlands are heavily dependent on local and regional groundwater flow systems. Without the continued input of groundwater in sufficient quantities into surface water bodies, cold water fisheries in head water streams could perish, the biodiversity in wetlands could decline, the waste assimilative capacity of watercourses could drastically subside, and recreational areas could worsen. Therefore, it is extremely important to take into full consideration the impacts of groundwater withdrawals and flow alterations on these systems.

Aquifer evaluation should be sensitive to relationships with watersheds and should attempt to describe their hydrogeology including their principal aquifers, and identify the interactions between surface and groundwater flow systems.

Public demand for information regarding the availability of groundwater supplies, well location, construction and well failures due to plugged casings, encrustation of well screens or corrosion of well casing and screens has been historically high and will increase in the future. To meet this demand, continued MOEE presence in the area of groundwater quantity management, full cooperation with our partners, and a solid database are

required.

4.2 Groundwater Contamination

Groundwater is susceptible to contamination as many types of pollutants can travel rapidly downward from the surface to the water table. Groundwater contamination can result from point or non-point sources.

Point sources of pollution that can impact ground water quality include municipal sanitary landfill sites, industrial waste storage and disposal sites, municipal and industrial liquid waste impoundments, major spills, underground gasoline storage tanks, mine tailings, radioactive wastes, coal tar sites, coal and coal ash from thermal power plants, PCB storage areas, deep well injection from industrial waste and brine disposal.

Non-point sources that can impact the ground water quality include industrial and municipal operations (pipelines, minor spills, and road de-icing salts), agricultural activities (fertilizer and pesticide use, animal wastes, and irrigation), urban drainage, septic systems, unprotected domestic and abandoned wells, acid rain and atmospheric fallout.

It is important to keep the relative impacts of various potential contaminant sources in perspective. For example, municipal and industrial landfill and disposal sites have a very high public profile, their approval is subject to lengthy public hearing, their potential impact on the quality of groundwater is extensively evaluated, and their operations are controlled by certificates of approval. Non-point sources of contamination, on the other hand, are more difficult to assess and control. The following points illustrate the potential impacts of non-point sources of contamination on ground water.

- Approximately, one million private septic systems exist in Ontario. Effluent from some of these systems may be seeping into the groundwater and exposing people to health hazards.

- Available data for the period 1966-87 indicate that the amount of applied nitrogen fertilizers in Ontario has increased from 68,673 to 216,466 metric tonnes. Nitrate Nitrogen is highly mobile and can easily leach into groundwater.

- Available data for 1988 indicate that approximately 1,000 metric tonnes of active ingredient atrazine are being used in Ontario. Atrazine has been making headlines across the U.S. lately as tests turn up residues of atrazine in groundwater and surface runoff. This prompted the U.S. EPA to reclassify atrazine as a restricted use material in 1990.

In Ontario, approximately 5% of water wells in agricultural areas show detectable amounts of atrazine.

- Approximately 1,400,000 metric tonnes of salt are being applied on our roads and highways annually and about 200 water wells are being investigated for salt contamination every year.

- In 1991/1992, a survey of groundwater quality of 1,300 water wells in rural Ontario showed that 37% of the wells were contaminated with nitrate or coliform bacteria.

MOEE staff investigate approximately 2,000 groundwater contamination incidents per year. Many of these incidents require action in the form of emergency control measures, water supply restoration, and site remediation. The economic impacts of groundwater contamination are staggering.

- In Elmira, the groundwater supplying the town was tainted by N-nitroso dimethylamine (NDMA), discovered in 1989 to have leaked from a chemical industrial plant. Remediation costs and costs associated with providing an alternative water supply could be in the range of $50,000,000.

- In Smithville groundwater and soil contamination by PCBs has required a large scale remediation program. The cost to date is in the range of $25,000,000.

- Perchloethylene (a dry cleaning solvent) in Manotick has contaminated the groundwater supplies of the community. Costs are in the range of $5,000,000 will be needed to provide alternative water supplies.

- Ontario's costs of dealing with water wells that were found to be contaminated by road salt for the fiscal year 1990-91 were $1,191,730.

The public is increasingly requiring information about water well bacteriological and chemical sampling and analysis, well disinfection, and the availability of point-of-use treatment devices. Demand for this information will continue to increase in the future.

As the population in the province increases, industrial and commercial activities will no doubt increase and demand for housing will rise. All these factors will result in an increase in the number of regulated and non-regulated point source discharges which could impact the quality of the groundwater resources. It is also expected that non-point sources of contamination from urban, agricultural and other activities will continue to exert pressure on groundwater quality.

Our experience indicates that once an aquifer is contaminated, it is extremely difficult to rehabilitate. Therefore, it is important to continue to protect groundwater quality now and for the future by:

- focusing on prevention of groundwater contamination rather than remediation.
- controlling all point source discharges;
- requiring the use of "Best Management Practices" for non-point sources of pollution;
- identifying existing sources of groundwater contamination and mapping of hydrogeologic conditions in the vicinity of existing and contaminated sources of groundwater;
- developing numerical groundwater limits (maximum allowable concentrations) to be used as a consistent upper limit on the allowable impacts from non-point sources; and
- protecting sensitive areas based using a scheme for groundwater classification based on the vulnerability of aquifers.

4.3 Global Warming And Severe Droughts

Is the Earth's climate growing warmer? According to meteorological records the mean temperature of the atmosphere has increased by slightly more than half a degree in the past 100 years. Other data indicate that the level of gases that trap the Earth's heat have also risen during this period.

The proportion of carbon dioxide in the atmosphere has risen by more than 20 percent and that of methane has roughly doubled. This correlation suggests a possible cause for the apparent affect. The proposition seems reasonable that the greenhouse gases are responsible for the warming trend. Yet the case is not airtight. It is conceivable that the matching increases in temperature and greenhouse gases are a statistical coincidence and that the two variables have nothing to do with each other in the long run.

Even if one accepts the proposition that global warming is taking place, it is not clear what the local effects of such a trend would be. Precipitation is the source of groundwater and any changes in precipitation amount and pattern would directly impact the availability of groundwater. Our main nemesis is a prolonged drought that could put tens and possibly hundreds of thousands of water wells out of commission.

Available climatic data show that Ontario has experienced a number of severe droughts during the past 50 years. It is a little known fact that the drought in the fifties, which resulted in the lowering of the water table in tens of thousands of water wells, was the main reason for the establishment of the Ontario Water Resources Commission.

While it is not possible at this time to provide a clear explanation as to why these droughts occur, and while it is hoped that climatologists will be eventually able to resolve the ambiguity about global warming, we can state with a great degree of confidence that we are going to experience severe droughts in the future. It is our hope that, through a long-term monitoring program of the variation of water table elevation, we will be able to detect the trend in time and implement the necessary measures to alleviate the expected water shortage problem.

5. PRINCIPLES OF GROUNDWATER MANAGEMENT IN ONTARIO

Ontario's emphasis on measures to improve surface and groundwater management began in the mid-fifties through the pioneering efforts of the Ontario Water Resources Commission, the conservation authorities, and in later years through programs of MOEE and the Ministry of Natural Resources. Ontario's approach to the management of ground and surface waters is based on three principles, which were highlighted in the Ontario Submission to the Inquiry into Federal Water Policy (1984). These principles are:

A. The watershed is the primary geographic basis for water management policy, planning and implementation.

This principle accepts the watershed as an ecosystem, integrating water and its use, land base and its use, and the environment surrounding both.

The principle reflects the intent of Ontario legislation, namely the Ontario Water Resources Act, the Environmental Protection Act and the Conservation Authorities Act. The principle focuses attention on the natural boundaries controlling water as opposed to administrative boundaries created by man.

The principle has been utilized through ground and surface water studies of watersheds such as the International Hydrologic Decade Representative Basins studies and the Thames, Grand, South Nation, and Credit River watershed studies.

While it is recognized that groundwater should be managed in terms of aquifers, there are inherent difficulties

associated with accurately defining the geographic extent of most aquifers. This difficulty often prevents land use planning and groundwater management issues from being dealt with on an aquifer specific basis. To resolve this geographic problem, while perhaps being technically inappropriate, groundwater is thought best managed on a watershed basis. It is important to understand, however, that a single aquifer may in fact involve several different watersheds.

B. Water requires multi-jurisdictional, cooperative management.

The first principle notes that water issues must be viewed on a watershed basis. It follows, therefore, that the development and implementation of policies, programs, guidelines, objectives and standards must be considered in a multi-jurisdictional context. Regardless of jurisdiction, actual or perceived, no single authority can effectively implement water management strategies without the cooperation of other parties involved.

There is a long history of cooperation between our provincial agencies on water management. Some of the best examples are the many watershed studies which have been completed throughout the province. In these studies, MOEE requested the input and the assistance of other ministries and agencies in the development of comprehensive water management plans for particular watersheds.

An effective monitoring program should capitalize on past inter-agency cooperation and achievements. The time spent on seeking inter-agency cooperation and consensus is a time well spent.

C. Water is a renewable natural resource that must be managed to provide optimum economic, social and environmental benefits.

Despite the renewable nature of ground and surface waters, total supply in the short-term is relatively fixed. In order to maintain and where possible increase the benefits from a fixed supply, demand management strategies will have to be considered. Examples include promotion of water conservation, the development of water efficiency standards, and water pricing policies that reflect the true cost to users.

The renewable nature of ground and surface waters is also a function of its quality characteristics. The Provincial Water Quality Objectives provide a basis for maintaining the existing high quality of our water resources and to upgrade

water quality where the Objectives are not met.

Continued economic prosperity requires that a balance between groundwater resource development and conservation is achieved to ensure the widest possible array of benefits to the people of Ontario. Monitoring of groundwater use is critical for the achievement of this principle.

6. AGENCIES INVOLVED IN THE MANAGEMENT OF GROUNDWATER IN ONTARIO

Groundwater management in Ontario is addressed at three levels of government: federal, provincial and municipal. The conservation authorities deal specifically with water management issues on a watershed basis, but recently they are showing strong interest in groundwater issues. In addition, academia and consulting firms conduct numerous studies, investigations and research projects that generate valuable information and data on groundwater quantity and quality. This information continues to enrich our understanding of the groundwater conditions in the province.

6.1 The Role Of The Federal Government

More recently, there has been an increased interest on the part of the Federal Government in groundwater management in Ontario arising from its jurisdiction over international affairs, in this case the management of the Great Lakes Water Quality and Fisheries.

The practical outcome of this jurisdictional fact is the Canada-Ontario Agreement on the Great Lakes Water Quality (COA). The Agreement came about so that Canada could fulfil its obligations under the Canada-United States Agreement on Great Lakes Water Quality. COA outlines the actions that Canada and Ontario will take to meet their obligations. Environment Canada cooperates with Ontario on the implementation of COA and provides funds for research areas traditionally considered in the provincial jurisdiction.

Annex 16 of the Canada-United States Agreement on the Great Lakes Water Quality deals with pollution from contaminated groundwater. It specifically states that the two Parties, in cooperation with State and Provincial Governments, shall:

i. identify existing and potential sources of contaminated groundwater affecting the Great Lakes;

ii. map the hydrogeological conditions in the vicinity of existing and potential sources of contaminated groundwater;

iii. develop a standard approach and agreed procedures for the sampling and analysis of contaminants in groundwater;

iv. control sources of contamination of groundwater and the contaminated groundwater itself, when the problems have been identified; and

v. report, to the International Joint Commission biennially, starting in December 1988, on progress in implementing Annex 16.

Lately, Agriculture Canada, has been very active in the area of groundwater management in rural Ontario. In 1991/92, Agriculture Canada, under the Green Plan Program, contributed $600,000 to conduct two surveys of groundwater quality in rural Ontario and is currently funding a number of initiatives aimed at improving groundwater for the farming community.

6.2 The Role Of The Provincial Government

At the provincial level, a number of ministries oversee legislation that have impact on groundwater management. These Ministries are: MOEE; Natural Resources; Health; Agriculture, Food and Rural Affairs; Transportation; Municipal Affairs; and Commercial and Consumer Relations.

6.2.1 Ministry of the Environment and Energy

The goal of MOEE is to protect and enhance the quality of the environment for the present and future well-being of the people of Ontario and of the ecosystem in which they live. Among other things, MOEE is charged with the conservation of the groundwater resources of the province and the control and use of these resources in an effective manner for the public good.

MOEE's mandate to manage the groundwater resources in Ontario is established in the Ontario Water Resources Act, the Environmental Protection Act, and the Pesticides Act.

The Ontario Water Resources Act, which is administered by MOEE, is the main legislative basis for the management of water in Ontario. The Act gives MOEE the responsibility for surface and groundwater. It provides the authority to control the taking of water; to regulate water well construction and licensing of well contractors and technicians; to define impaired water quality; to prohibit the discharge of polluting material; and to regulate the discharges of sewage. In addition, the Act requires that the Minister be notified of abnormal discharges into water, and provides options to enact regulations related to:

- drinking water standards,
- the use of water from any source, and
- well construction, maintenance, use, cleaning, decontamination, and abandonment.

The purpose of the Environmental Protection Act is to provide for the protection and conservation of the natural environment. The Act is administered by MOEE. Under the Act, waste sites or landfills in the province are regulated on a case-by-case basis. Active sites operate under Certificates of Approval issued under the Act.

The Act prohibits the discharge of any contaminant into the natural environment in any amount exceeding that prescribed by regulation or at any level that is likely to cause the impairment of the natural environment. The Act empowers the Director to issue control orders to limit or control the discharge of contaminants; and sets out the procedures, manner, and equipment to be used in controlling the discharge of contaminants.

The purpose of the Pesticides Act is to control the use of chemicals for the destruction of plant and animal pests and to investigate the possible harmful effects of pesticides on the environment. The Act is administered by MOEE.

later addition

The Pesticides Act prohibits improper use of pesticides; requires notification of MOEE of abnormal pesticide discharges,;empowers MOEE to issue stop orders and control orders for improper handling, storage, use, disposal, transport or display of pesticides; and empowers the Minister to order responsible party to repair, decontaminate or prevent impairment to the environment from improper pesticide use.

Throughout the years, MOEE has produced many regulations, policies, and guidelines related to groundwater under the Ontario Water Resources Act and the Environmental Protection Act. It has also assembled a wealth of information and a vast amount of data related to Ontario's groundwater resources.

6.2.2 Ministry of Natural Resources

The Ministry of Natural Resources (MNR) has a mandate to ensure a continuous contribution to the economy by stimulating and regulating the utilization of renewable and non-renewable resources. With respect to water management, MNR's mandate is the management of water-based resources, such as fisheries, wildlife and the regulation of streamflow. MNR's interest in water quality arises from its mandate over fisheries. The Federal Fisheries Act is administered in Ontario by MNR. Data generated through MNR's monitoring programs are extremely

valuable in identifying streams with cold water fisheries that are fed mainly by groundwater.

A plan of subdivision of public lands usually is prepared by MNR and submitted to the Ministry of Municipal Affairs. It is circulated to other ministries and Health Units for comment. MNR also comments on proposals for private development of land around lakes, or adjacent to public lands, which may be affected by the development.

In recent years, mainly as a result of the Ontario Government's decision to consider the Oak Ridges Moraine as an area of provincial interest, MNR has paid special attention to the groundwater resources of the Moraine. MNR is the leading agency in investigating the impacts of land use changes due to increased urbanization on the quality and quantity of the groundwater resources in the Moraine.

6.2.3 Conservation Authorities

In Southern Ontario and parts of Northern Ontario, MNR has delegated some of its responsibilities for the regulation of streamflow and water-related land management to the conservation authorities. These authorities operate under the auspices of the Conservation Authorities Act, which is administered by the Aquatic Ecosystems Branch, Southern Ontario Region of MNR.

The conservation authorities generally encompass one or more drainage basins and have as their objectives to: "... establish and undertake programs, in the area over which they have jurisdiction, designed to further the conservation, restoration, development and management of natural resources other than gas, oil, coal and minerals" (Conservation Authorities Act).

The conservation authorities give high priority to programs designed to operate and maintain existing water control structures and projects, followed by flood forecasting programs. Nevertheless, they have actively participated in all the watershed studies carried out by the province including the groundwater studies. Recently, a number of conservation authorities are showing increased interest in their groundwater in an effort to protect their recharge zones, wetlands and cold water fisheries. The Credit River Conservation Authority went a step further by funding an MOEE evaluation of their groundwater resources.

6.2.4 Ministry of Municipal Affairs

The Ministry of Municipal Affairs (MMA) administers the Planning Act, which is the basis for municipal land use planning and the

approval process for consents and plans for subdivisions. The MMA Minister has the approval authority for official plans and their amendments as well as plans for subdivisions and condominiums.

With ever increasing numbers of developments that rely on groundwater being proposed, there is a great demand to establish groundwater or "well head" protection programs. Experience shows that although well head protection programs can be established through the Water Resources Act, it is much easier to establish them through amendments to Official Plans and zoning bylaws under the Planning Act. Currently, a number of municipalities are following this route.

6.2.5 Ministry of Agriculture, Food and Rural Affairs

The Ministry of Agriculture, Food and Rural Affairs (OMAFRA) is interested in issues related to water management not only because agriculture is a major user of water in the province, but also because it is a major generator of wastes and a principal user of chemicals (fertilizers and pesticides). These facts make the interrelationships among cropping systems, management of agricultural chemicals, soil conservation, water quality, drainage and land use very strong.

OMAFRA, along with municipal governments, administers the Drainage Act, which covers drainage works to control the water table within agricultural lands. In addition, OMAFRA and MOEE administer the Agricultural Code of Practice, which outlines measures that have to be incorporated in the design of facilities and the utilization of manure to minimize air and water pollution problems.

During the last fifteen years, OMAFRA implemented a number of environmental programs aimed at encouraging the farming community to adopt the use of "Best Management Practices". These progams were delivered in cooperation with Agriculture Canada and several farm organizations.

In June 1990, OMAFRA published its Strategic Plan. One of the strategic actions of the Plan is: "to investigate and respond to issues related to soil degradation, farm water supplies, agricultural impacts on ground and surface waters, agriculture chemical use, agriculture and food processing waste, and air quality".

One of the mandates of OMAFRA is to administer the land drainage program and to participate in government planning of water resources. OMAFRA in cooperation with Statistics Canada generates annual information on agricultural chemical use and livestock operations in the province. In addition, it surveys

pesticides use in the province every five years. These surveys, which determine the amounts and types of pesticides used in Ontario, are invaluable in assessing the potential risks to groundwater through pesticide use.

6.2.6 Ministry of Health and Health Units

The Ministry of Health (MOH) involvement in groundwater management in the province originates from its administration of the Health Protection and Promotion Act. Across much of the province, responsibility for Part VIII of the Environmental Protection Act has been delegated to the health units under agreements signed between the Crown and local Boards of Health Units or, in some cases, the Regional Municipalities. Exceptions exist in areas where there are no agreement in effect and MOEE carries out these responsibilities.

The health units have been active in carrying out thousands of bacteriological, and specific chemical analyses of groundwater samples that are submitted by well owners. These analyses are performed free of charge. Unfortunately, this database remains largely untapped.

6.2.7 Ministry of Consumer and Commercial Relations

The Ministry of Consumer and Commercial Relations (MCCR) administers the Gasoline Handling Act which regulates petroleum storage tanks. Groundwater contamination from leaking gasoline storage tanks is a major problem in Ontario. MCCR has recently established a system to keeps records on new petroleum storage tanks installed in the province.

6.2.8 Ministry of Transportation

The Ministry of Transportation (MTO) does not have any direct mandate over water management. Their mandate is the design, construction, and maintenance of roadways. MTO frequently conducts pre-construction surveys but does not consult with MOEE to see if the studies are adequate. The data is usually kept on file in MTO offices.

Spreading of salt on roads during winter results in the contamination of about 200 water wells every year. A cost-sharing agreement between MOE and MTO was designed to address these problems.

6.3. The Role Of Municipalities

The mandate of municipalities in water management comes from the Municipal Act which empowers them to pass bylaws related to water activities in areas under their jurisdiction.

Municipalities, through the planning process, can have a significant influence on the impact of land use on surface and groundwater quality. They fund groundwater investigations and studies to assess drinking water supplies. The delineation and protection of sensitive aquifers within Official Plans and the establishment of well head protection programs are avenues that are being explored by some municipalities.

Municipalities maintain records of daily groundwater takings. They also monitor the quality of drinking water and have established a monitoring network in their well fields to observe groundwater level fluctuations.

6.4 The Role Of Academia And Consulting Firms

Academia and consulting firms, mainly through research projects and hydrogeologic investigations, generate a lot of information and data on groundwater conditions in various parts of Ontario. Most of this of knowledge is scattered in reports and files that would require a great deal of time and effort to capture. Given that this knowledge is of great value, the time and effort required to capture and organize it, would be well spent.

7. GAPS AND NEEDS RELATED TO OUR PARTNERS IN GROUNDWATER MANAGEMENT

1. Recognizing the multi-jurisdictional nature of groundwater management in Ontario, the cooperation, consultation, and communication on groundwater with our partners (the federal and provincial agencies, conservation authorities, municipalities, academia, and consulting firms) should be enhanced.

2. In cooperation with our partners, an effort should be made to assemble and computerize the enormous amount of data related to groundwater that has been and are being generated, including:

   - the results of bacteriological and chemical analyses conducted by the health units;

   - the amounts and locations of road salt applications carried out by MTO and road authorities;

   - the results of pesticide tests conducted by OMAFRA;

- the data on fertilizer and pesticide applications in Ontario, which are being assembled by OMAFRA and Statistics Canada;

- the data gathered during watershed planning exercises; and

- the vast quantity of information and hard data generated by Ontario's consulting community

3. The cooperation among MOEE staff who deal with groundwater issues should be strengthened through:

- improved communication and consultation;

- the establishment of an MOEE Standing Committee on Groundwater; and

- the holding of groundwater seminars on an annual basis.

practical/research oriented?

RATIONALE FOR MONITORING - BACKGROUND, CURRENT STATUS, GAPS AND NEEDS

1. GENERAL COMMENTS

Groundwater monitoring is defined as **"....the set of activities that provide chemical, physical, geological, biological, and other environmental data needed by managers and decision-makers to assist in developing and implementing groundwater protection policies and programs".** Thus, groundwater monitoring is viewed as a continuum of activities ranging from defining background conditions, to defining the existence and extent of contamination, to defining the success of prevention and response measures and programs to protect the groundwater resources.

Based on the above definition, it is possible to conclude that groundwater monitoring that is limited to ensuring compliance with legislation or conducting local investigations without an inventory of the resource, is of limited use. Without a thorough inventory of the resource, it is not possible to design an effective groundwater monitoring program. From a practical point of view, a combined program of resource inventory and monitoring, phased in over a period of years and implemented in priority areas, is the most appropriate way to proceed.

In order to prevent adverse effects to human health and the environment, and protect and enhance the environmental integrity of Ontario's groundwater resources, two levels of monitoring activities are required:

- long-term ambient monitoring to establish spatial trends, temporal trends, and early warning indicators of environmental stress; and
- compliance, investigative and landuse monitoring.

2. LONG-TERM AMBIENT MONITORING

As indicated above, a successful long-term groundwater monitoring program requires basic inventory about groundwater conditions in the province. Such an inventory can be obtained through the establishment of a long-term aquifer mapping program.

Aquifer mapping will not only determine the use, economic value, and vulnerability of Ontario's principal aquifers, but would provide indispensable information for the establishment of an effective groundwater monitoring network. Therefore, aquifer mapping and the establishment of a groundwater monitoring network

are two indispensable elements of a long-term groundwater monitoring program.

2.1 Aquifer Mapping

A great body of knowledge has been accumulated in Ontario about its groundwater resources. In 1969, the Ontario Water Resources Commission published its first drainage basin report in its Water Resources Series. This tradition was continued after the incorporation of the Commission within then Ministry of the Environment (MOE) until 1982. Twenty four reports were published, which provided detailed information on the groundwater resources of various watersheds, including information on groundwater flow systems, bedrock topography, overburden and bedrock geology, and hydrochemistry.

Between 1973 and 1978, MOE published the Major Aquifers in Ontario Map Series consisting of eight maps which covered most of Central and Eastern Ontario. The Series identified major aquifers in terms of their areal extent and groundwater yield potential.

The Groundwater Probability Map Series was initiated in 1969. Between 1969 and 1986, fourteen maps were published. These maps covered a large area in Southwestern and Central Ontario and illustrated the potential availability of groundwater in these areas.

Due to budgetary constraints, the MOEE's efforts in evaluating the groundwater on a watershed basis were terminated in 1982. Exceptions are the Credit River watershed study that was funded by the Credit Valley Conservation Authority and the Severn Sound study that is currently being funded by the Wye Marsh Wildlife Centre. Also, MOEE's efforts in the field of publishing Major Aquifer Map Series and Groundwater Probability Map Series ended in 1978 and 1986, respectively.

In order to provide adequate water supplies to an increasing population and protect groundwater from contamination, conservation authorities and other provincial and federal agencies are increasingly demanding aquifer maps and groundwater evaluations on a watershed basis. As indicated above, some of these clients are willing to fund such studies. Therefore, it is essential for the appropriate management and protection of groundwater resources in Ontario to revive the Aquifer Mapping Program, and to continue groundwater evaluation studies in Ontario on a watershed basis.

The objectives of the Aquifer Mapping Program should be:

- the establishment of criteria to define principal aquifers in Ontario;

- the identification of principal aquifers; and

- the ranking the aquifers according to their susceptibility to contamination.

2.2 Groundwater Monitoring Network

MOEE had in place a province-wide network of observation wells to monitor groundwater levels for detailed hydrogeologic budgeting studies, water supply forecasting in municipal well fields, and resolution of groundwater quantity interference complaints. Between 1974 and 1979, six reports were published summarizing the data and providing hydrographs of the observation wells. Currently, only a few of these observation wells are still being maintained by some MOEE Regions.

A long-term aquifer monitoring program would significantly improve the management and protection of groundwater in Ontario. A groundwater monitoring network strategically distributed across the province can incorporate some, if not all, of the old observation wells. Such a program will provide valuable information on the natural groundwater level and quality variations within the principal aquifers over time. Stresses due to water withdrawals and water quality degradation due to changes in land use can be assessed on a continual basis and remediation measures can be instituted in a timely fashion.

The goal of the Groundwater Monitoring Network should be to define the temporal and spacial variations in water quantity and quality within principal aquifers of the province for the purposes of managing and protecting of Ontario's groundwater resources.

The objectives of the Groundwater Quality Network should be:

- the establishment of observation wells to provide groundwater quality and water level variations data;

- the establishment of sampling protocol and quality assurance program to ensure consistent and reliable data;

- the development of a database management system linked to other related databases;

- the incorporation of existing high quality data into the database;

- the provision of "snapshots" of existing groundwater quality and groundwater level variations to identify potential problems; and

- the maintenance of the database to assist in the formulation

of groundwater protection policy.

Data collected through the Drinking Water Surveillance Program (currently, 25 municipal systems), audits of municipal groundwater supplies, monitoring of municipal groundwater fields, provision of communal water supplies, and developments on individual private wells are very high in quality. All efforts should be directed to incorporate these data into the Groundwater Monitoring Network's database.

3. GAPS AND NEEDS RELATED TO LONG-TERM AMBIENT MONITORING

1. Aquifer mapping is essential for the appropriate management and protection of Ontario's groundwater resources. It provides the necessary background information to establish an effective long-term groundwater monitoring program. If MOEE is to make a commitment to groundwater monitoring, it is necessary that we revive the Aquifer Mapping Program.

2. As part of deliberation to establish the Aquifer Mapping Program, appropriate criteria should be established to compile a priority list of aquifers and watersheds so that the Program can meet critical needs as they emerge.

3. MOEE does not have a long-term groundwater monitoring network. It is essential to establish such a network. It advisable to establish the network in phases and to make use of the old piezometers that were installed by the previous Ontario Water Resources Commission.

4. All efforts should be directed to incorporate the data collected under the Drinking Water Surveillance Program, audits of municipal groundwater fields, provisions of communal water supplies, and developments on individual private wells into the Groundwater Monitoring Network's database. It is recommended to accomplish this task through a phased-in program and customized electronic reporting.

4. COMPLIANCE AND INVESTIGATIVE MONITORING, AND LAND USE PLANNING REVIEWS

Groundwater compliance monitoring is intended to ensure compliance with legal requirements and with Agreements with other parties signed by the Ontario Government. There are two main bodies of law in Ontario: the common law and statutory law. Common law is the body of rules established by judges over the past centuries in the course of making decisions in disputes between people. The statutory law is the codification of an existing common law or of a new law as determined by the legislator at the time of enactment.

In order to comply with the requirements of common and statute law and contractual or other agreements, compliance monitoring and land use planning reviews involve a significant amount of groundwater information collected across Ontario. By and large, the information and the data are scattered in various files in MOEE's Head and Regional offices. Some of these data such as the number of Permits to Take Water, water well complaints, and various approvals are readily available in various Regional offices.

Once computerized, and interpretation and reporting formats are established, these data can be used to identify broad **"groundwater monitoring indicators"** (e.g. the number and frequency of public complaints regarding groundwater quantity, the number of issued Permits to Take Water in a given area or aquifer, the number of reported dry wells in an area, etc).

Such indicators could shed light on the long-term trends in the depth to the water table, the changes in the demand being placed on groundwater, the stresses being placed on shallow aquifers by surface sources of contamination, the effectiveness of Ontario's buried tanks regulations, and many others.

The groundwater monitoring indicators can provide insights into the overall health of Ontario's groundwater resources and help in the identification of groundwater issues that would require greater attention. By focusing on the issues rather than on a particular well or aquifer, the real stresses on the resource can be identified and the risks of overlooking potential threats will be minimized.

Just as there is a significant amount of information collected through compliance monitoring and land use planning reviews, our Ministry's own investigations generate a large quantity of high quality groundwater data. A problem that we are faced with, however, is that the results of the thousands of chemical analyses that are being conducted and reported every year by the Laboratory Information System are not geographically referenced. This places severe restrictions on the use and the long-term usefulness of these data.

To make better use of the data, it should be a requirement to take readings of the geographic coordinates of all the water samples taken in the field by using Geographic Positioning System (GPS) equipment.

By making a small investment in purchasing a few GPS equipment for every Regional Office, and by computerizing the database(s) that are on file in these offices, it would be possible to establish the number, frequency, and type of public complaints. In addition, by utilizing the capabilities of our Geographic Information Systems (GIS), it would be feasible to produce maps of the locations of confirmed public complaints regarding groundwater quantity; the locations and amounts of groundwater withdrawals under the Permit to Take Water Program; and the locations of confirmed complaints related to the spreading of road salt, leakages from underground gasoline storage tanks, and other groundwater quality interferences. Such maps would be of great value to our Regional staff and will allow them to focus their limited resources to areas that are at risk.

In the following sections, the numerous activities which currently generate groundwater quantity and quality data are discussed. By understanding the broad diversity of programs which involve the generation of groundwater data, we can better appreciate the advantages of having the data entered into a well organized database. The establishment of a well coordinated groundwater monitoring program and data management system will aid enormously with all of these activities.

4.1 Groundwater Quantity

Water quantity management in Ontario involves a combination of common law, and federal and provincial statutes. The major federal statute affecting groundwater quantity management in Ontario is the Fisheries Act, which has been used to protect the fisheries in Ontario streams from the impacts of certain drainage works that resulted in lowering the water table and reduced streamflows. The major provincial statute affecting groundwater quantity management is the Ontario Water Resources Act.

Three major policies on groundwater quantity management were

advanced in the MOEE publication entitled: **"Water Management: Goals, Policies, Objectives and Implementation Procedures of the Ministry of the Environment, 1978"**, also known as the "Blue Book".

Unfortunately, the term "policy" was also been used to describe official policies as defined by the MOEE Policy Manual. To eliminate confusion, one has always to keep in mind that the policies advanced in the Blue Book are in essence broad principles that describe MOEE's philosophy and approach to water management.

The first "Blue Book" policy deals with Permits to Take Water. It states that:

> **"groundwater takings will be controlled to prevent water supply interference wherever possible through a water taking permit program."**

The second policy is related to the resolution of interference problems and states that:

> **"... in the event of a groundwater taking authorized by permit interferes with another water supply obtained from any adequate source that was in use prior the issuance of the permit, the party causing the interference shall restore the affected supply or reduce the taking to eliminate the interference."**

The third policy is related to groundwater conservation. The policy states that:

> **"all reasonable measures shall be taken to promote the conservation of groundwater."**

Currently in Ontario, there are a number of programs and processes in place that address the legislative and other requirements regarding groundwater quantity. The following sections provide a brief overview of these initiatives.

4.1.1 MOEE Water Well Program

Regulation 903, under the Ontario Water Resources Act, is intended to regulate the water well drilling industry and to ensure that newly constructed water wells meet minimum requirements in terms of construction, maintenance, and abandonment. The Regulation requires well drillers to submit a copy of every newly constructed well within 30 days after the completion of the well. Since 1946, MOEE has accumulated approximately 600,000 well records and this number is increasing at a rate between 12,000 to 20,000 new records every year.

The water well record is a document designed mainly to protect the interest of the well owner should a problem related to poor well construction arise, or should maintenance or repairs become necessary. The record is equally important to MOEE in regulating the water well construction industry, in conducting investigations of water well quantity or quality interference problems, and in assessing the status of groundwater use in the province.

The MOEE water well records are in great demand by the drilling industry (well drilling and water bottling), consultants (groundwater investigations), municipalities (municipal water supply, land use planning), academia (research projects), and provincial and federal agencies (hydrogeologic investigations, land use planning, agricultural chemical impacts on groundwater, and protection of environmentally sensitive areas).

The water well record contains information on up to 212 parameters including:

- Location: county or district, township, borough, city, town or village, lot, concession, and watershed.
- Geology: geologic formations encountered during drilling;
- Water: depths at which water was found, depth to static level, and the kind of water found in terms of being fresh, salty, sulphurous, or containing iron or gas.
- Pumping test and well yield.
- Well construction: details of casings, screens, plugs, and seals.
- Surface elevation.
- Date of completion.
- Name and address of well owner and well driller.

Between 1972 and 1984, a massive effort was undertaken by the Ministry to identify the geographic coordinates and elevations of the water wells and to create a computerized database, which is known as the MOEE Water Well Information System (WWIS). Currently, the WWIS contains approximately 400,000 well records.

Unfortunately, MOEE's efforts to add new records to the WWIS were terminated in 1984. Since then only about 30,000 records were added to the data set, mainly, through funding by Agriculture Canada, the Regional Municipality of Waterloo, and the Credit Valley Conservation Authority with some internal support by MOEE. As a result a backlog of about 170,000 well records exists.

Without identifying the geographic coordinates and elevations of the wells, data from the well records cannot be used with GIS systems and our ability to correlate these new data with other geographically referenced data would be severely curtailed. Therefore, it would be extremely useful to identify, in the field, the locations and elevations of all newly constructed wells using GPS equipment.

Our experience indicates that the total cost of identifying the geographic location, elevation and the entry of the record into the computer system ranges from $10 to $15. Hence, the cost of eliminating the backlog range from $1.7 to $2.5 million and the annual cost of entering the new data ranges from $120,000 to $300,000. Unfortunately, our current annual budget of $40,000 covers only the licensing part of the program and the manual storage of new records.

One way to generate funds is to establish a well permit fee of $100.00 on every newly constructed well in the province through an amendment to Regulation 903. Such a fee could generate between $1.2 to $2.0 million annually and could cover all the costs associated with the implementation of a comprehensive groundwater protection and management program, which includes monitoring.

Another option that could reduce our costs is to make it a requirement of every well driller in Ontario to use GPS equipment to identify the coordinates and elevation of every new well, and to submit this information as part the well record. This option would also require an amendment to Regulation 903. Given the low costs of GPS equipment, such requirements will not be onerous and would save the province all the costs associated with field identification of well coordinates and elevations, which are estimated to range from $100,00 to $260,000 annually.

4.1.2 Permit To Take Water Program

MOEE administers the Permit to Take Water Program under the Ontario Water Resources Act. The program requires most water takings in excess of 50,000 litres per day be authorized by means of permits. An application for a Permit to Take Water (PTTW) is reviewed in light of information concerning availability of the supply, the use to which the water is to be put, and the effects of the proposed taking on existing uses including streamflow.

Applications for PTTWs are associated with communal water supplies, irrigation, pit and quarries operations, groundwater treatment (contamination clean-up), short-term takings (construction dewatering, testing), and miscellaneous takings (structural drainage works, recreation). Communal water works and contaminated groundwater treatment systems may also require

Certificates of Approval as well as PTTWs.

The review of Certificates of Approval and PTTW applications for communal water supply require the submission of reports on engineering design, hydrogeology, well construction, pumping tests, water quality, and proposed treatment. Information on the number of lots, industrial and commercial operations to be serviced, population figures, and storage capacity should also be included.

The hydrogeologic report should include information on the hydrogeology of the area; location of wells, observation wells and test holes; well records; geologic cross-sections; estimates of the recoverable recharge; groundwater quality (prior to, during and after pumping); assessment of susceptibility to contamination and the need for well head protection; an assessment potential interference with either groundwater or surface water; and a monitoring scheme to trigger a contingency plan to prevent interference and validate the resolution of interference claims.

PTTW applications for contaminated groundwater treatment systems also require Certificates of Approval. The approval process of such applications requires, among other things, the submission of information on hydrogeology, an assessment of potential for interference with water supply of other users, a monitoring scheme, and a contingency plan.

The information that is required to be submitted as part of PTTW applications that are not associated with Certificates of Approval is similar to those described above, but on a much reduced scale.

All information and data received by MOEE under the PTTW program are filed in various Regional offices. It would be extremely useful to computerize all these information and data.

4.1.3 Groundwater Quantity Interference Investigations

A complaint of water quantity interference, caused by a third party, that results in the lowering of the water table in a well below the pump level or in the drying up of the well, is investigated by MOEE Regional staff. The intent of the investigation is to identify the cause of the problem and recommend corrective actions. The scope of the investigation and the amount of monitoring data collected depend on nature of the problem and the local geologic conditions.

4.1.4 Water Supplies for Developments on Individual Private Wells

A hydrogeologic study is required by MOEE prior to recommendation of draft approval for plans of subdivisions and condominiums that obtain their water supplies from individual private wells. The hydrogeologic report should address the issues of supplying future residents with water, well construction techniques, and adverse impacts of contamination sources. With respect to quantity, each future domestic well must provide sufficient water for normal domestic purposes, which will be determined on the basis of data from pumping tests in test wells.

4.1.5 Reviews of Official Plans

As a result of an Agreement between MOEE and MMA, municipalities may, during the development of their Official Plans under the Planning Act, undertake hydrogeological assessments for planning purposes. MOEE staff review these studies and provide comments.

4.2 Groundwater Quality

Common law affecting groundwater quality management is rooted in the principle that a person's activities should have no more than a negligible impact on an adjacent property owner. This principle is reflected in Section 1 (a) of Environmental Protection Act when it defines "adverse effect" as follows:

> "Adverse effect" means one or more of,
>
> (i) impairment of the quality of natural environment for any use that can be made of it,
>
> (ii) injury or damage to property or to plant or animal life,
>
> (iii) harm or material discomfort to any person,
>
> (iv) an adverse effect on the health of any person,
>
> (v) impairment of the safety of any person,
>
> (vi) rendering any property or plant or animal life unfit for use by man,
>
> (vii) loss of enjoyment of normal use of property, and
>
> (viii) interference with the normal conduct of business.

The federal statutes affecting groundwater quality management in Ontario are the Canada Water Act, The Fisheries Act, the Pest Control Products Act and the Fertilizers Act.

The provincial statutes affecting groundwater quality management are the Water Resources Act, The Environmental Protection Act, the Environmental Assessment Act, the Pesticides Act, the Health Protection and Promotion Act, the Gasoline Handling Act, and the Petroleum Resources Act. In addition to the law, a number of policies, guidelines and protocols exist which affect the management of groundwater quality in Ontario.

Two major policies on groundwater quality management were advanced in the Blue Book. One policy is related to regulated sources of contamination. The policy states that:

> **".... waste control requirements for proposed regulated waste discharges will be established on a case-by-case basis. As a general policy, water quality degradation will be controlled in order to protect reasonable uses, existing or proposed, both of ground and surface waters".**

The policy also indicates that the requirements of MOEE relating to the quantity and quality of the discharge will be specified and control measures and monitoring requirements may be stipulated in a **Certificate of Approval**.

The second policy on groundwater quality management is related to unregulated sources of contamination. The policy states that:

> **"all reasonable measures shall be undertaken to reduce or prevent the contamination of groundwater by proposed or existing unregulated activities".**

In order to facilitate the implementation of the policies contained in the Blue Book, a number of additional policies were developed. Policy 15-08 entitled: **"Incorporation of the Reasonable Use Concept into Groundwater Management Activities of the Ministry of the Environment"**, is perhaps one of most notable of these policies and it was formulated under the Ontario Water Resources Act.

Policy 15-08 describes how the reasonable use of groundwater can be determined on a case-by-case basis and how to determine how much contamination could be conservatively allowed without impairing the use of a neighbour's groundwater.

In addition, Policy 15-10 was developed to deal with unregulated sources of contamination such as existing or proposed non-point sources (crop fertilization, manure and pesticide application, road de-icing), unlicensed and closed landfills, leaks and spills and decommissioning cleanup. The Policy establishes the urgency of MOEE response and a procedure for determining the extent or degree of cleanup that Ministry would require.

MOEE reviews numerous monitoring programs to ensure compliance

with the above policies and related guidelines. Hydrogeologic information and monitoring data collected as a result of compliance with MOEE's Acts, regulations, policies, and guidelines are kept on file at various Head and Regional offices.

4.2.1 EPA Part VIII Approvals

Those who live in rural, un-serviced (i.e., no municipal sewers) areas of Ontario rely on individual sewage treatment and disposal systems. The most common form of such a system is a septic tank and a leaching bed located within the boundaries of a property. These systems may serve an individual home, a public institution, a commercial or an industrial operation.

For an isolated, single family dwelling, the risk of a negative impact upon groundwater quality is negligible when the minimum requirements specified in Ontario's regulations on septic systems are met. This is not the case, however, for a subdivision where a large number of closely-spaced systems are employed or when a large single system is required for a school, a restaurant, a shopping centre, or an industrial park. In such instances, the impacts of the system on the quality of groundwater as well as the principles of common law have to be considered under the Reasonable Use Policy.

The responsibility for deciding what constitutes the reasonable use of the groundwater and what uses should be protected will normally rest with the MOEE Regional Director. The Regional Director will base his decision upon the site assessment report prepared by the consultant and staff's assessment of that report.

Where there is disagreement about a calculation of the impact of a large subsurface sewage disposal system, it may be possible to resolve this disagreement with a groundwater monitoring program. Unlike contaminant discharges from landfills, discharges from large subsurface sewage disposal systems can be controlled if monitoring indicates this is necessary.

4.2.2 Environmental Assessment Reviews

The objective of hydrogeologic investigation in an Environmental Assessment for a landfill is to collect sufficient hydrogeologic data about a large area so that one or more sites can be identified for landfilling. This is accomplished through a reconnaissance hydrogeologic mapping and site investigation program. The objective of the hydrogeological investigation under part V of the Environmental Protection Act, on the other hand, is to collect sufficient hydrogeologic data on a specific site so that it can be designed to meet MOEE's requirements.

MOEE staff, in their review of an Environmental Assessment study for prospective landfill sites, require the following information:

- identification of hydrogeologically suitable areas and settings;
- identification of hydrogeologically suitable sites and landfill design concepts; and
- ranking of selected sites.

Copies of information submitted for Environmental Assessment reviews are filed in various Regional offices.

4.2.3 Waste Management Reviews

The MOEE Reasonable Use Policy states that the Ministry will protect reasonable groundwater uses on properties adjacent to waste disposal activities. In assessing a proposed site or a site wishing to expand, a proponent must show that the estimated potential contaminant discharge from the site meets the limits specified in the Reasonable Use Policy.

In order to arrive at a sensible estimate, the proponent must identify the geologic unit(s) or aquifer(s) to be protected, identify the particular contaminants that are of concern, and estimate the maximum impacts of these contaminants on the unit(s).

Any proposal for landfilling must include a monitoring plan and a contingency plan. The monitoring plan is a document that details all construction, operation, maintenance, and supervision of a ground or surface water observation network for the routine collection and interpretation of data to protect the environment. Monitoring may range from an extensive program involving the weekly collection of gas and/or water samples to no more than a yearly inspection of the site.

The contingency plan outlines specific measures to be undertaken in response to unanticipated events. The plan would be implemented if monitoring indicates that some aspects of the design or operation of the site are faulty.

4.2.4 Closed Waste Sites

The objectives of the program are to identify obvious hazards to human health that can be recognized during a file search and site inspection, establish an up-to-date information database on closed waste sites that have been classified in the MOEE 1991

Waste Site Inventory as having the potential to impact human health, and to initiate and manage hydrogeological investigations on these sites.

Over the next five years, the Closed Waste Site Program will involve the inspection/evaluation of 279 sites, and the reassessment of 98 sites that were ranked as medium or high priority in a previous evaluation conducted in the eighties.

Site assessment will involve file search, review of geological and hydrogeological information, visual site inspection, and evaluation of need for further study. Since the assessments are limited, mainly, to file searches and visual inspections, they will only be used for identifying obvious impacts and potential impacts to nearby receptors. No "clean bill of health" will be given to any site. The three prime considerations in an assessment are: hazards from the migration of methane gas, hazards from the migration of leachate impacting surface water bodies, and hazards from the migration of leachate impacting groundwater.

4.2.5 Orphan Site Remediation

In October 1989, the Canadian Council of Ministers of the Environment initiated a five year program to clean up contaminated sites in Canada. A Canada/Ontario Agreement was signed on March 28, 1991 to implement and demonstrate remedial measures at orphan, high risk, contaminated sites. Six sites were identified in Ontario including: Smithville, Hagersville, Deloro mine, Rednersville, National Hard Chrome, and Port Stanley.

It is expected that by the end of the program, remediation work will be complete, except for monitoring, at Hagersville, Rednersville, National Hard Chrome, and Port Stanley. Remedial activities will continue at Smithville and Deloro mine beyond March 31, 1996.

4.2.6 Industrial Site Decommissioning

The decommissioning of industrial sites requires the proponent to demonstrate that certain environmental standards related to groundwater quality have been met. The proposed Guidelines for the Decommissioning and Cleanup of Sites in Ontario consists of an expanded list of chemical criteria on which to judge soil contamination, and allowance for risk assessment to be used in some situations to determine the cleanup strategy.

Impacts on surface and groundwater are addressed in the guideline and form the basis for total or partial cleanup at depth options. In all cases, cleanup at the surface (1.5 m) is required to protect human health and/or the environment.

Allowance is also provided for modified generic criteria to be used in the total cleanup option, or the surface cleanup criteria portion of the partial cleanup option. However, whichever options are selected, protection of human health and/or the environmental ecosystem remain of paramount significance and must be achieved as a result of site cleanup.

As a first step in determining the likelihood of contamination on a site, all available historic data are reviewed and a sampling program is conducted. The second step involves detailed sampling, analysis and data assessment to the nature and degree of contamination of soil on the site, and the impacts this contamination has on air quality, and ground and surface water on and off-site.

Following the completion of the cleanup, the proponent must undertake a verification sampling to establish that the cleanup have been achieved. Monitoring may be necessary in some cases to ensure that the cleanup has produced the desired effect. Decommissioning reports are reviewed by Regional staff.

4.2.7 Miscellaneous Industrial Approvals

Certain industrial approvals require hydrogeologic investigations and reporting. These reports are reviewed by MOEE Regional staff who identify potential problems and possible corrective actions.

4.2.8 Environmental Audits

Many industries voluntarily undertake environmental audits of their properties. This would include items such as aeration-stabilization basins, coal storage areas , and salt water infiltration facilities. Increasingly, such audits are submitted to MOEE for review and comparison with established environmental standards.

4.2.9 Miscellaneous Site Specific Monitoring Programs

Under certain circumstances, MOEE will establish groundwater monitoring programs around specific sites such as the Bruce nuclear plant, Hagersville, Smithville, and Manotick TCE spill. The objectives of such monitoring activities is to ensure public health and safety and in some cases to improve the understanding of specific hydrogeologic processes.

4.2.10 Groundwater Quality Interference

Complaints made by the public regarding groundwater quality problems are investigated by MOEE Regional staff in order to find the causes and suitable resolutions.

5. GAPS AND NEEDS RELATED TO COMPLIANCE AND INVESTIGATIVE MONITORING

1. There is a need to computerize the Regional data, to establish interpretation and reporting formats, and to identify broad groundwater monitoring indicators. Such a program can be phased-in over 5 years and the costs, which are estimated at $50,000.00 annually, could be shared by Head Office and the Regional Operations Division.

2. Once the data are computerized, there is a need to identify broad **"groundwater monitoring indicators"** (e.g., the number and frequency of public complaints regarding groundwater quantity, the number of issued Permits to Take Water in a given area or aquifer, the number of reported dry wells in an area, etc).

3. To make better use of the data that are collected under the compliance and investigative monitoring programs, there is a need to require readings of the geographic coordinates of all the water samples taken in the field.

4. There is a need to eliminate the existing backlog of water well records and to institute in place a program to deal with the new records.

5. There is a need for a province-wide computer database on PTTW takings.

MONITORING REVIEW

DRINKING WATER

NOVEMBER 1994

DRINKING WATER MONITORING REVIEW

November 24, 1994

by

DRINKING WATER MONITORING REVIEW

WORKING GROUP

DRINKING WATER MONITORING REVIEW
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DRINKING WATER MONITORING REVIEW

1. Introduction

1.1 Task

The program review process will assess existing Provincial drinking water monitoring programs and their tie-in with other agencies' monitoring efforts, and determine/recommend future directions for drinking water monitoring in the province. This will be accomplished by:

- reviewing existing monitoring activities to identify current monitoring initiatives;
- determining stakeholder and client needs and relationships together with data and reporting requirements;
- identifying monitoring and program gaps, including costs;
- providing options and giving recommendations for future drinking water monitoring directions, addressing the need for integration of monitoring efforts, data optimization and utilisation, partnerships and effective reporting.

The following are members of the Working Group from Environmental Sciences and Standards Division (ESSD) and Operation Division (OD). Members from ESSD were appointed by the individual Branch Directors and from OD by the ADM:

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1.2 The Issue/Media

Drinking water is essential for humans. It should not contain substances (e.g., metals, organics) or micro-organisms at levels that would result in adverse physiological effects. Drinking water must also be aesthetically acceptable. It can be consumed in any amount without concern for adverse health effects.

Drinking water is a **product** that can, through treatment, be made to conform to any quality limits, however selecting the best source water available will minimize treatment costs. Extensive treatment is usually required on surface water sources; treatment for ground waters is generally limited to disinfection.

In Ontario there are two major sources of drinking water: surface water (primarily the Great Lakes) and ground water. Water systems can be categorized into municipal, private communal (trailer parks, camp grounds, etc.) and individual private supplies. There are more supplies using ground water than surface water, however, supplies using surface water provide drinking water to the majority (about 80%) of the population. Municipal ground water supplies frequently contain many individual wells, often from different aquifers. Table 1 summarizes the categories, sources of drinking water systems and population served:

Table 1. Summary Of Drinking Water Supplies.

TYPE OF SUPPLY	SURFACE	GROUND	POPULATION
Municipal	194	269	8,500,000
Communal	*	12,000	350,000
Private	** 200,000	600,000	1,800,000

* There are an estimated 12,000 private communal supplies in Ontario, the majority are ground water supplies. The ratio of ground water/surface water is unknown.

** Most of these are seasonal supplies.

Drinking water, in addition to its use for personal consumption, is used in the household for domestic uses from bathing and washing clothes to toilet flushing, by industry in many industrial

processes some of which may require additional treatment, for farm irrigation, and as a necessity for fire fighting.

Residences (domestic use) are the largest users of drinking water accounting for 35% of municipal supplies followed by industrial users at 26% and institutions (hospitals, universities etc.) at 23%. Upwards of 16% is unaccounted for through leaks or other losses. Among domestic uses the most common is toilet flushing (41%) followed by washing and bathing (37%) and consumption and cooking (11%). In 1985, the total estimated municipal water produced in Ontario was 4.5 million m^3/d (1000 million Imperial gallons per day).

Agriculture, although a small user of drinking water acquires importance because of the demands it makes on ground water supplies. Agricultural water use serves two primary purposes: irrigation and stock watering. Irrigation accounts for 43% of agricultural water use with 57% used for livestock watering. There are about 4,000 water users involved in irrigation and 34,500 who water livestock.

Drinking water supplies can be contaminated by many routes. The source water may be contaminated by municipal or industrial effluent discharge or run-off from agricultural activities. Ground water wells may be poorly constructed, located adjacent to a waste disposal site leaching toxic wastes or drilled into rock that leaches minerals. Spills of toxic materials may also affect source water quality. Extensive treatment may be required if the source water is significantly contaminated.

Treatment chemicals themselves may be a source of contamination. Chlorine, used as a disinfectant, imparts a taste to the water and can elevate levels of disinfection by-products. In the distribution system, cross contamination is a possibility and corrosion in household plumbing can result in increased levels of some metals.

The acute health effects associated with contaminated drinking water are usually caused by disease causing organisms but short-term effects can be caused by elevated sulphates and some young bottle-fed infants are susceptible to methaemoglobinaemia (blue baby syndrome) due to excess nitrate in the water. Chronic effects are usually associated with long-term exposure to elevated levels of toxic chemicals.

The aesthetic quality of drinking water is affected by many parameters. Hardness, if too high, can cause scaling in pipes and appliances; elevated levels of iron and manganese can cause laundry and fixture staining; some chemicals and byproducts can cause taste and odour problems at concentrations magnitudes lower than what would be considered a health risk. The perception of the safety and aesthetic quality of drinking water can be influenced by information in the media or elsewhere.

Most drinking water quality limits are set through a Federal/Provincial process. Each province and territory has representation on the Federal/Provincial Subcommittee on Drinking Water which establishes the Guidelines for Canadian Drinking Water Quality (CDWGs). These limits are generally adopted by Ontario as Ontario Drinking Water Objectives (ODWOs). Ontario may elect to make their limits more stringent than the CDWGs or develop its own limits as was recently the case for N-nitrosodimethylamine (NDMA).

The ODWOs are set for health-related parameters including chemical compounds and microbiological organisms, parameters that can affect the aesthetic quality as well as operational guidelines to improve treatment processes. In the ODWO publication are some recommended sampling guidelines but these are **minimum** frequencies and parameters and are not to be considered adequate in all situations.

Drinking water that does not comply with ODWOs can result in direct effects to human health and therefore effective monitoring for compliance is essential. Since the presence of disease causing organisms can have an immediate effect on public health, sufficient bacteriological testing to ensure that the water is free of these organisms is paramount. Health-related parameters must also be monitored with sufficient frequency to ensure delivery of a safe supply. Parameters that contribute to the aesthetic quality of drinking water should also be examined. In addition, monitoring the treatment process and associated parameters ensures control within the plant and the distribution system.

In this report the discussion will be limited to municipal drinking water supplies. The monitoring of municipal drinking water quality is shared by the municipalities which supply the water, the Ministry of Environment and Energy, the Ministry of Health and the Ministry of Labour.

Monitoring alone will not guarantee safe drinking water. Testing can only measure the quality of water at the time of sampling. Analytical results may not be available for hours or even weeks after the fact. For that reason several other program components are essential to ensure safe drinking water:

- selection of a good source water;
- optimized treatment (appropriate design, treatment processes and operation, certified operators);
- maintenance and inspection procedures;
- sufficient monitoring and timely data evaluation;
- suitable limits and the procedures to use them effectively;
- effective procedures to find new contaminants and develop appropriate guidelines.

In any sampling program, the data are only as good as each of the parts that is used to generate the results. These parts include sampling location, sample tap, bottle and preservative used,

shipping and storage, analysis method, numerous data validation steps and proper interpretation for reporting. A failure in any one aspect nullifies all the effort in the others. Unfortunately in many sampling programs this information is unknown or not documented.

2. Priority Environmental Issues

Drinking water quality is a major environmental issue that has, and continues, to receive broad public attention. Figure 1 provides an overview on the many factors (which themselves are generally considered environmental issues of concern) that have an impact on drinking water quality. These issues have been differentiated in terms of three major steps in the drinking water process: source water quality, treatment, and distribution and are further described in Table 2.

Specific needs, limitations or gaps in current drinking water monitoring programs that arise from these issues are identified below:

SOURCE WATER QUALITY

As identified in Figure 1 and Table 2, there are many factors which impact the quality of surface or ground waters in the province. Current drinking water monitoring efforts endeavour to provide a comprehensive assessment of the quality of the source water as a means of determining both treatment needs and efficiencies. These monitoring programs are reactive in that they signal a change of water quality after the change has been detected. Although the primary focus is on maintaining the quality of the drinking water through treatment practices, attention may also be placed on identifying and correcting, if possible, the cause of the deterioration of source water quality.

For many sources which are used for drinking water there are specialized and ongoing monitoring programs which characterize the quality of the source water or the discharges to it. These monitoring programs have been developed to address specific needs and objectives and have been implemented as independent activities.

TREATMENT

Major issues associated with treatment practices include:

1. ability and efficiency in removing or destroying chemical contaminants and microbial agents;

2. creation of byproducts from the process; and

3. unwanted residuals from treatment chemicals.

Although sound operational practices have been established to ensure that drinking water quality is both acceptable and consistent over time, ongoing monitoring of the treated water is required for validation and public assurance. Judgement is required both in determining which parameters require monitoring and the frequency of that monitoring. Given that significant expenditures may be required, the basis for monitoring needs to be clearly rationalized.

Pressures on monitoring include the ongoing assessment of byproducts of treatment, particularly disinfection, and the possibility that these may be added to future monitoring lists.

DISTRIBUTION

The distribution system may have an impact on the quality of water delivered to the consumer though the corrosion and leaching of contaminants from the distribution system/plumbing components. In addition, distribution system design and integrity should be sufficient to prevent incursion/growth of harmful microorganisms.

OTHER ISSUES

The drinking water monitoring program is dependent on analytical support and standards for interpreting the results. These aspects of the program need to be coordinated to accommodate both the need for new or improved analytical methods to identify and quantity contaminants in drinking water, and the need for new or revised standards to determine acceptable levels of contaminants in drinking water.

3. Responsibility for Monitoring

3.1 Legislative

In Ontario, the Ontario Water Resources Act (OWRA) is the legislation that governs municipal and communal water systems. Municipalities are responsible for ensuring that a water of adequate quality is delivered to consumers. Private operators of water supply systems falling under the OWRA are also responsible for the quality of water at the consumer's tap. Water supplies not governed by the OWRA are the responsibility of the owner, although, monitoring of health-related contaminants is done by local health agencies.

Figure 1. Priority Environmental Issues Related To Drinking Water Quality

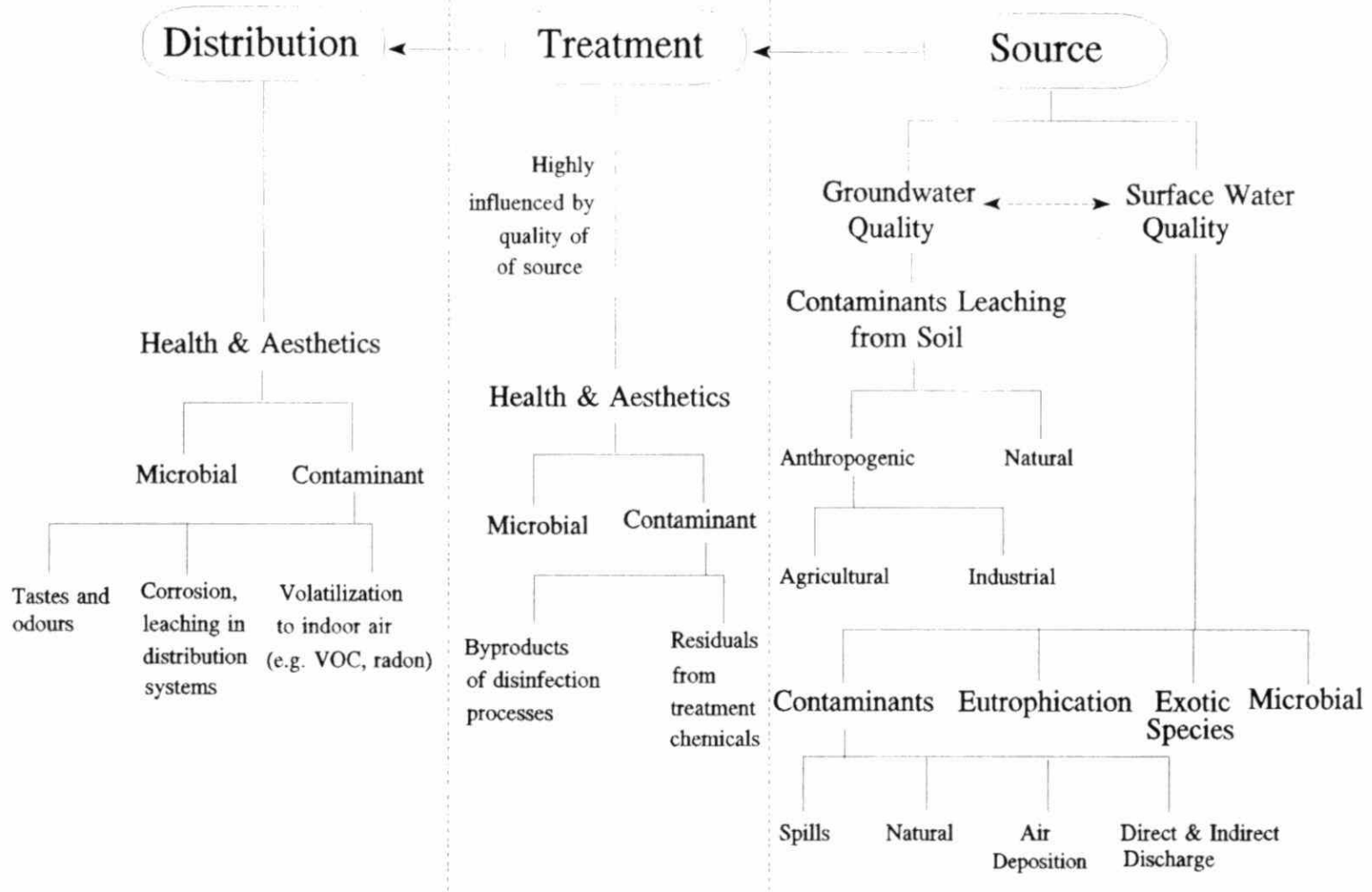


Table 2. Drinking Water Monitoring Program Review - Impact To Drinking Water.

ISSUE	SUB-ISSUE	ISSUE DESCRIPTION
SOURCE	**GROUND WATER QUALITY**	Quality will depend upon the nature of the aquifer, geological considerations and leaching from contaminated soil or surface water.
	Soil contamination (leaching)	Depending on soil and chemical properties leaching may occur from soil to water table impacting on the quality.(eg contamination from natural sources: - arsenic and uranium from natural geology; contamination from anthropogenic sources - NDMA, Elmira, leaking underground storage tanks; agricultural use of pesticides)
	SURFACE WATER QUALITY	Quality will depend on the geological, physical, biological and climatological factors and manmade inputs.
	Biological Agents	Pathogenic bacteria, protozoa (e.g. Cryptosporidium, Giardia), and viruses are of concern re: efficacy of the treatment process. Decomposition of algae can cause taste and odour problems.
	Exotic Species	Introduction of exotic species can impact on the useability of the source for drinking water purposes and may require additional treatment practices.(eg zebra mussels and chlorination)
	Eutrophication	Impacts on the treatment requirements for drinking water.(eg high organic content and formation of THMs)
	Contaminants	Quality will depend upon the amount of runoff, direct discharge and/deposition.
	Spills	Chemicals spilled may impact acutely on the drinking water supply.(eg St. Clair River, Chemical Valley)
	Air Deposition	Long term impact on drinking water with continual deposition.(eg tritium; heavy metals and organics from incinerators/combustion processes)
	Direct and Indirect Discharges	Effluents from industrial processes which are discharged directly or indirectly into surface water impact on the quality of drinking water.
TREATMENT	**TREATED WATER QUALITY** **Health and Aesthetics**	The treatment process is dependent on the quality of the source water and may contribute to residuals in the finished drinking water.
	Treatment Chemicals	Residuals from treatment chemicals can have an impact on the quality of water.(eg Aluminum from treatment with alum)
	Byproducts	Byproducts created by the water treatment process have an impact on the quality of the finished water from both a health and aesthetics perspective.(eg THMs from chlorination; formaldehyde from ozonation)
	Microbials	Assurances that the treated drinking water is of adequate microbiological quality is paramount in assuring that there will be no negative health impacts on the population.
DISTRIBUTION	**DISTRIBUTION WATER QUALITY** **Health and Aesthetics**	The distribution system may affect the quality of the water.
	Corrosion/Leaching	Corrosion/leaching(eg lead, antimony) may adversely impact the quality of the finished water.
	Indoor Air Quality	Volatilization of chemicals from drinking water (i.e. shower) may impact on the indoor air quality and provides an additional route of exposure(inhalation) (eg radon).
	Microbials	Assurances that the distribution system does not biologically contaminate the treated water.
	Taste and Odour	Seasonal consumer complaints of taste, odour and other aesthetic problems.

Since 1988/89, the Approvals Branch of the MOEE, through the issuance of Certificates of Approval (C of A), requires that drinking water quality satisfy the **most current** Ontario Drinking Water Objectives and specifies monitoring requirements. Regional staff of the MOEE are responsible for enforcing the Certificate of Approval at all water supply systems (Ministry, municipal or privately operated). See Appendix III for a more detailed description of the Approval Process.

The Medical Officer of Health, through the Health Protection and Promotion Act (Chapter 10, Part 3, Section 10, 11, 12 and 13), is the authority to judge whether water is safe for human consumption. Regional staff of the MOEE co-operate with local Medical Officers of Health in controlling potential health problems associated with municipal and communal water supplies.

3.2 Mandate

The MOEE and before that the Ontario Water Resources Commission has always taken the lead in municipal drinking water issues and this has been very beneficial to the water industry, since it has promoted uniformly high standards of operation that results in excellent drinking water quality. As well it has resulted in a superior working relationship between most purveyors and the Ministry that has achieved remarkable results without the necessity of regulations to force compliance. This partnership relies on mutual trust and the common desire to produce the best product possible.

The public also expects the Ministry/Government to take the lead role in protecting the public health through the production of uniformly safe drinking water. This has been achieved with numerous Ministry programs that include approval of treatment plant design and operation, development of guidelines, procedures and collection of data. Within the last item, is the development of sampling protocols and analytical methods as well as data management systems that has kept Ontario at the leading edge of drinking water technology.

4. Rationale for Monitoring

Monitoring is carried out to:

- ensure that drinking water delivered to the consumer is safe and aesthetically pleasing;
- identify treatment needs, financial impacts and modifications in frequency of monitoring as a result of change and/or degradation of the resource; and,
- secure public confidence.

There are three basic sample types for drinking water: the raw water prior to treatment; the treated water leaving the plant; and the distributed water delivered to the consumer. Each type of sample serves several functions:

- **RAW WATER** - This is the water entering the treatment plant and it provides:
  - a measure of raw water quality which allows assessment and adjustment to treatment processes;
  - a means to measure treatment efficiency;
  - information on the source of contaminants;
  - long term trends in raw water quality;
  - when combined with the treated and distributed results, more confidence in those results due to the validation checks that can be made. This confidence is enhanced when the three sample types are sampling the same block of water as in the Drinking Water Surveillance Program (DWSP).

- **TREATED WATER** - This is the water entering the distribution system after the treatment is complete providing:
  - information on treatment efficiency, when combined with the raw data;
  - a good estimate of the consumed drinking water quality for those parameters that do not change during distribution, e.g., pesticides, PCBs, and mercury.

- **DISTRIBUTED WATER** - This is the water consumed by the public. Free flowing or flushed samples taken at the consumer's tap provide:
  - information on the quality of drinking water that is actually consumed;
  - information on those parameters that are expected to change during distribution e.g., THMs and metals such as lead;
  - when combined with the treated water a measure of the effect of the distribution system on water quality.

  A **standing** sample from the consumer's tap can also be taken and this provides:
  - information on the leaching of metals from the distribution system or the consumer's plumbing into the drinking water;
  - worst-case conditions for metals, e.g., lead, if the tap is not adequately flushed;
  - the effectiveness of corrosion control practices.

The confidence in drinking water results is greatly influenced by the quality of the monitoring program. More confidence can be placed on the results if:

- adequate samples are taken of raw, treated and distributed water;
- samples are taken at sufficient frequency that seasonal or temporal variation is apparent;

- there are documented and appropriate sampling and analytical protocols; and
- there are validation checks throughout the sampling, analytical and data management procedures.

Since drinking water monitoring data provide the basis for many important decisions involving human health and the expenditure of millions of dollars, it is essential that this data be of high quality. Appropriate sampling, analytical and reporting protocols are necessary to ensure the quality of data. That data must be readily accessible, preferably in a high quality database that allows multi-faceted reporting.

"Poor" data (i.e., data from samples/programs without adequate quality assurance) could increase the risk to human health and result in the needless expenditure of millions of dollars.

When assessing drinking water it is very beneficial if the data user is able to look at the "complete picture" which includes raw, treated and distributed water along with the plant processes, chemical dosages and appropriate field data. This allows proper interpretation and validation that frequently can be based on chemical relationships. The sources of any contaminant can frequently be established quickly and the appropriate remedial action recommended without extensive resampling, which is important with a health-based exceedance.

Drinking water monitoring may be used to ensure compliance with established guidelines/policies, to monitor treatment efficiencies (i.e., process control), to evaluate site specific problems, to provide data necessary for establishing/revising drinking water guidelines, and to assess long term trends in drinking water quality.

4.1 Compliance

- to determine compliance with Ontario Drinking Water Objectives or limits and guidelines from other agencies in the absence of ODWOs;

- to determine compliance with Certificates of Approval.

4.2 Process Control

- carried out in the plant to control the treatment process (e.g., pH, chlorine residual, turbidity, particle counting) and to monitor treatment efficiency.

4.3 Assessment

- to investigate through research or surveys perceived or potential problems;

- to respond to complaints;

- to define cause and effect relationships, thereby aiding in the identification of appropriate remedial action;

- to support guideline development for specific contaminants;

4.4 Long-term Trends

- to monitor a specific set of indicators temporally over the long term;

- to determine ongoing trends and identify changes in water quality;

- to provide an early warning of the development of detrimental conditions;

- to identify specific environmental spacial and temporal trends at water treatment plant intake locations.

5. Monitoring Discussion

5.1 Existing Monitoring Programs

The Working Group identified ten programs that deal directly or indirectly with the monitoring of municipal drinking water. These programs were described in a series of questionnaires. The information is summarized in several tables under the four monitoring categories of compliance, process control, assessment and long-term trends as well as number of plants, frequency and type of samples, population monitored and most importantly data quality (see Appendix II). They vary greatly in their coverage (number of locations, number of parameters and sampling frequency) and data quality.

Figures 2-5 show the number of plants sampled with the associated population, the number of parameters analyzed and the types of samples taken, the sample frequency and type of database supporting the individual program and the length of time the program has been active.

1. **Drinking Water Surveillance Program** (DWSP) currently samples about one quarter of all supplies representing 80% of the population served by municipal supplies. It samples the raw, treated and distributed water with a variable frequency of 2 to 6 times per year, depending on the raw water source, for up to 180 parameters plus a mass spectrometry characterization

and has been in operation for 8 years. It has a centralised electronic database and extensive reporting capability.

2. The water plant **Intake Sampling Program** samples raw water for 11 parameters at a small number of selected locations with a weekly frequency. It has an electronic database with simple reporting capability and has been operating for 18 years. (This program is part of the Surface Water Program Review)

3. **Sewage and Water Inspection Program** (SWIP) samples all municipal surface and ground water supplies in Ontario. However, it samples raw and treated water with a frequency of only once in 2 to 4 years for 20 - 150 parameters and has been operational for 5 years. There is no electronic database and hard copies of the data are kept at the Regional offices. This program is explained in detail in Appendix IV.

4. **Approvals** of Regional Operations Division has issued Certificates of Approval (C of A) that require monitoring for about one quarter of all municipalities representing about 70% of the population served by municipal supplies. When a municipal supply has several water sources, such as multiple surface water treatment plants or several wells on different aquifers, each would require its own C of A. They require the purveyor to sample raw and treated water and analyze for 70 or more parameters at frequencies varying from daily to annually and is site specific. It has no database and all records are maintained by the purveyor. Details are provided in Appendix III.

5. **Specific Contaminant Response** (SCR) samples specific plants for specific parameters (e.g., dioxins and NDMA) at a weekly to monthly frequency. There is currently no database.

6. The **Ministry of Health** (MOH) microbiological testing program samples about three quarters of all plants (mainly smaller locations) representing 65% of the population served by municipal supplies. It samples the raw, treated and distributed water but only for microbiological parameters at a frequency dependent on the population served. There is an electronic database with simple reporting capability along with hard copies.

7. **Radiological Monitoring** samples raw and treated water at a few plants within a given radius of a nuclear installation for specific radiological parameters with weekly and monthly composites. There are hard copies of the results available and it has been operating for 12 years.

8. **Special Surveys** such as the 1st Nation's reservations conducted in Ontario or the National Disinfection By-Products (DBP) Survey conducted by Health Canada will be needed

periodically to answer specific questions. Usually the sampling is short-term and often includes only certain locations or parameters.

9. **Purveyor Monitoring** is conducted at all plants to a greater or lesser degree. All locations sample for microbiological parameters and many conduct extensive monitoring of chemical parameters. Municipalities like Metro Toronto, Windsor and Ottawa conduct detailed testing. Also the Regions are now requesting that municipalities sample for the ODWOs at least annually. The extent of this monitoring is presently not known but it should be determined to prevent overlaps and enhance available data. Quality and availability of this type of data will be discussed later.

10. **Utility Monitoring Information System** (UMIS) contains the summarized data (monitoring by the purveyor) for about one quarter of all plants representing about 33% of the population served by municipal supplies operated by the Ontario Clean Water Agency (OCWA). UMIS contains information on the raw, treated and some distributed water for a limited number of physical/chemical and microbiological parameters at a monthly frequency. It has an electronic database with simple reporting capability and only stores the data for 3 years plus the current year.

The programs can be grouped into four basic types:

- Compliance/Trends in Monitoring/Surveillance
- Specific Programs - "one time" or one purpose result
- Immediate Monitoring
- Process Control

and are depicted in Figure 6 showing populations monitored by each individual program.

Figure 2. Number Of Municipal Water Supplies And Population Monitored

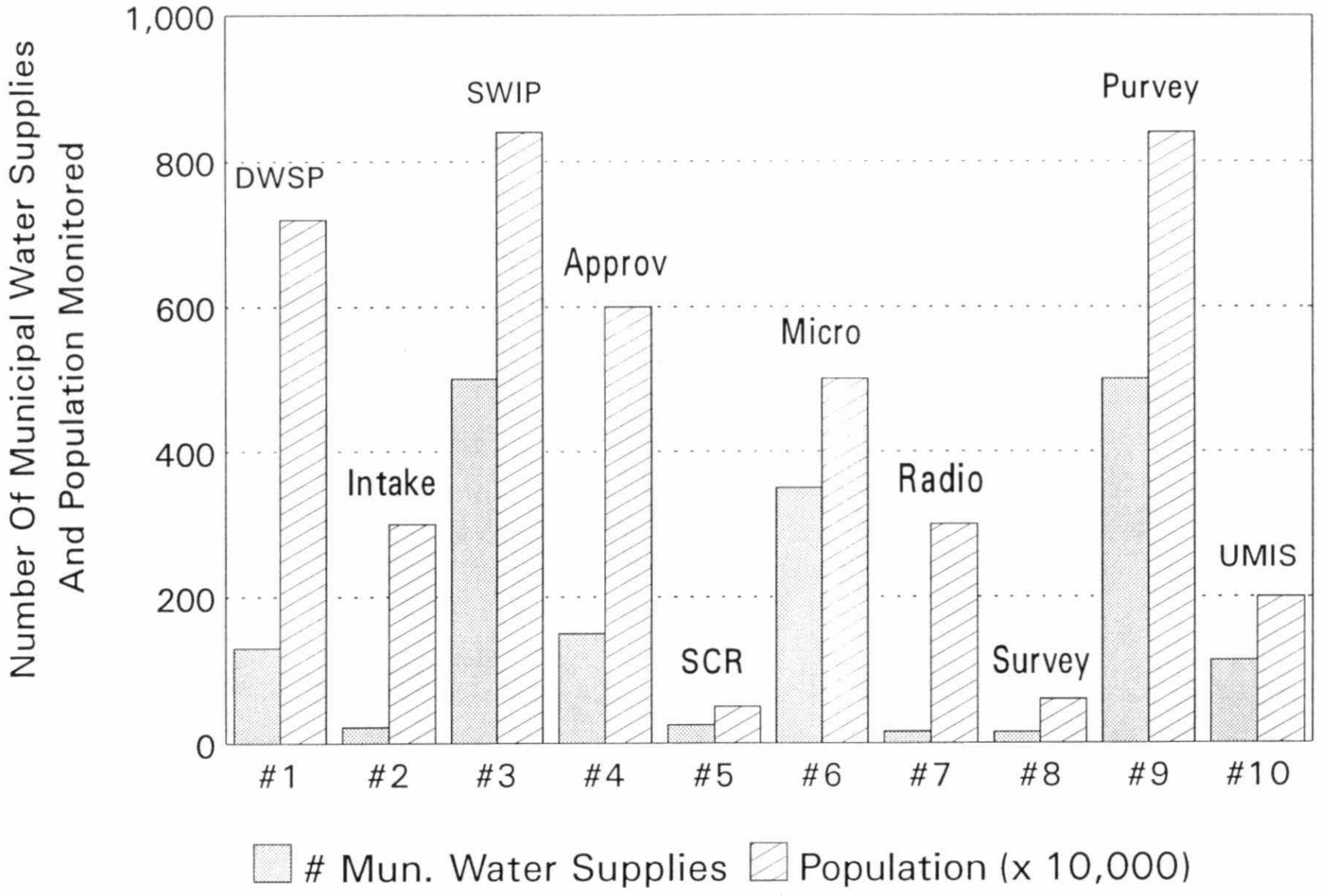
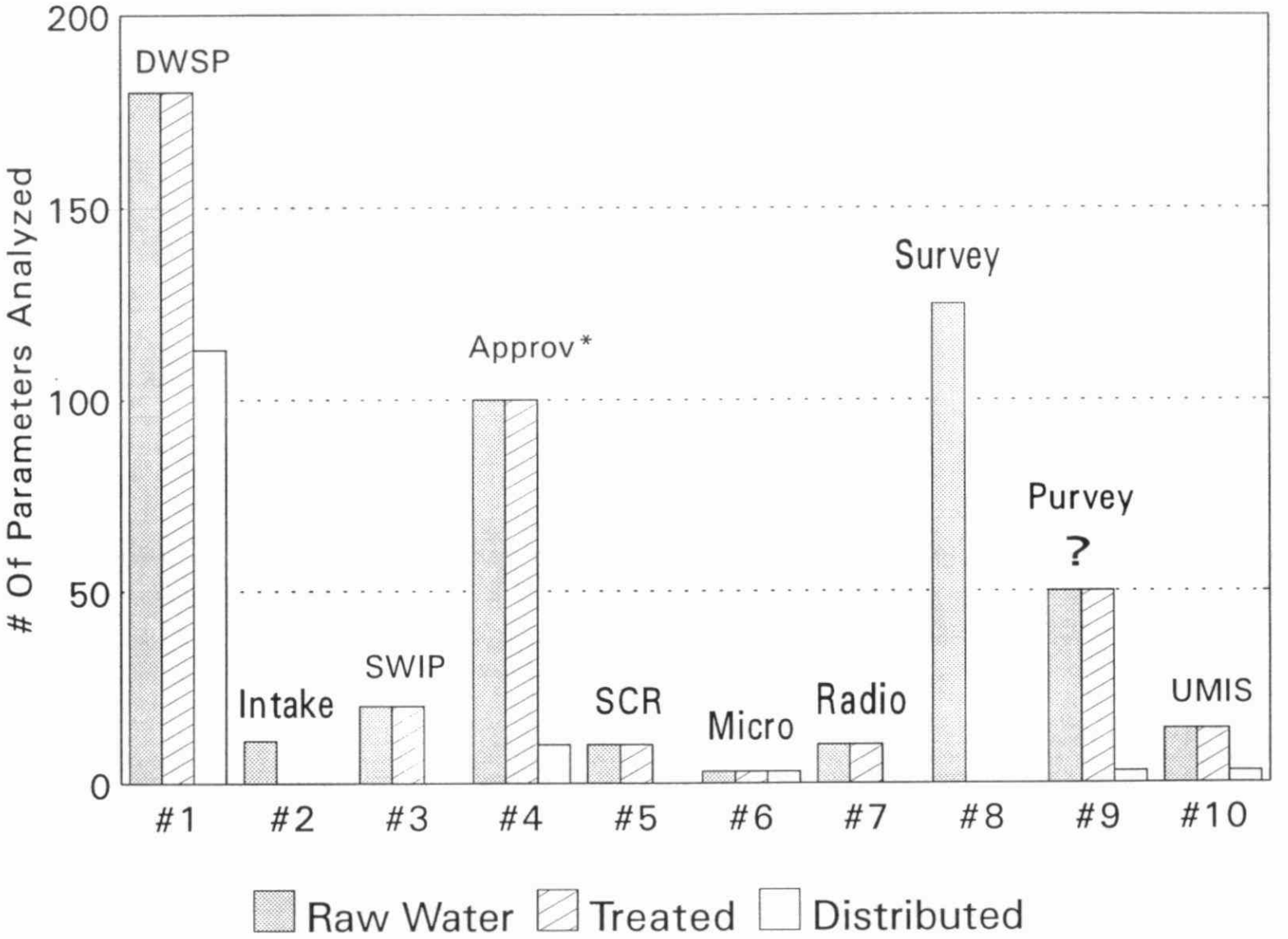
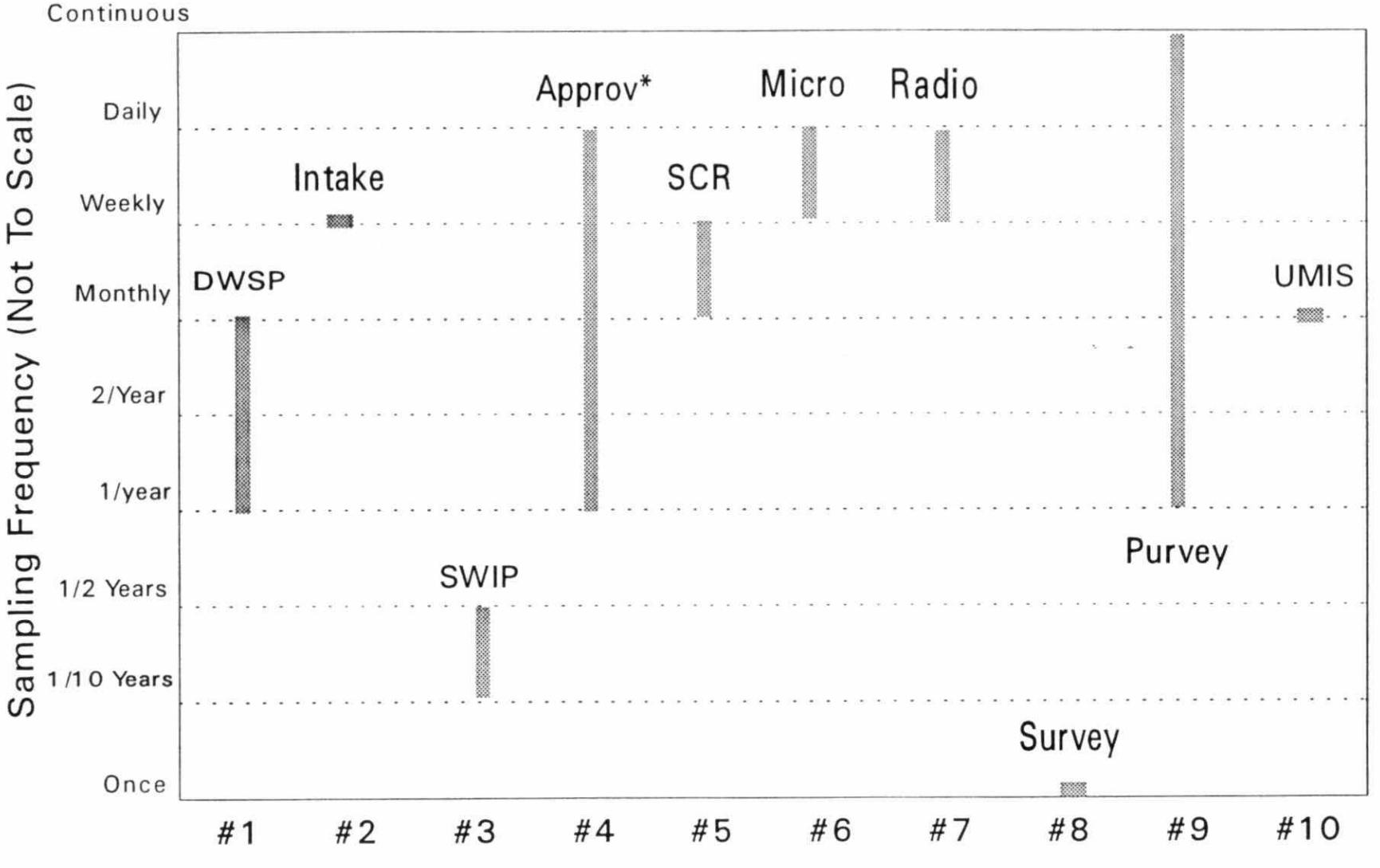


Figure 3. Number Of Parameters Analyzed



*Monitoring requested by C of A; done by purveyor or DWSP

Figure 4. Frequency Of Sampling



*Monitoring requested by C of A; done by purveyor or DWSP

Figure 5. Database Capabilities, ODOE ($), And Person Years For Existing Programs

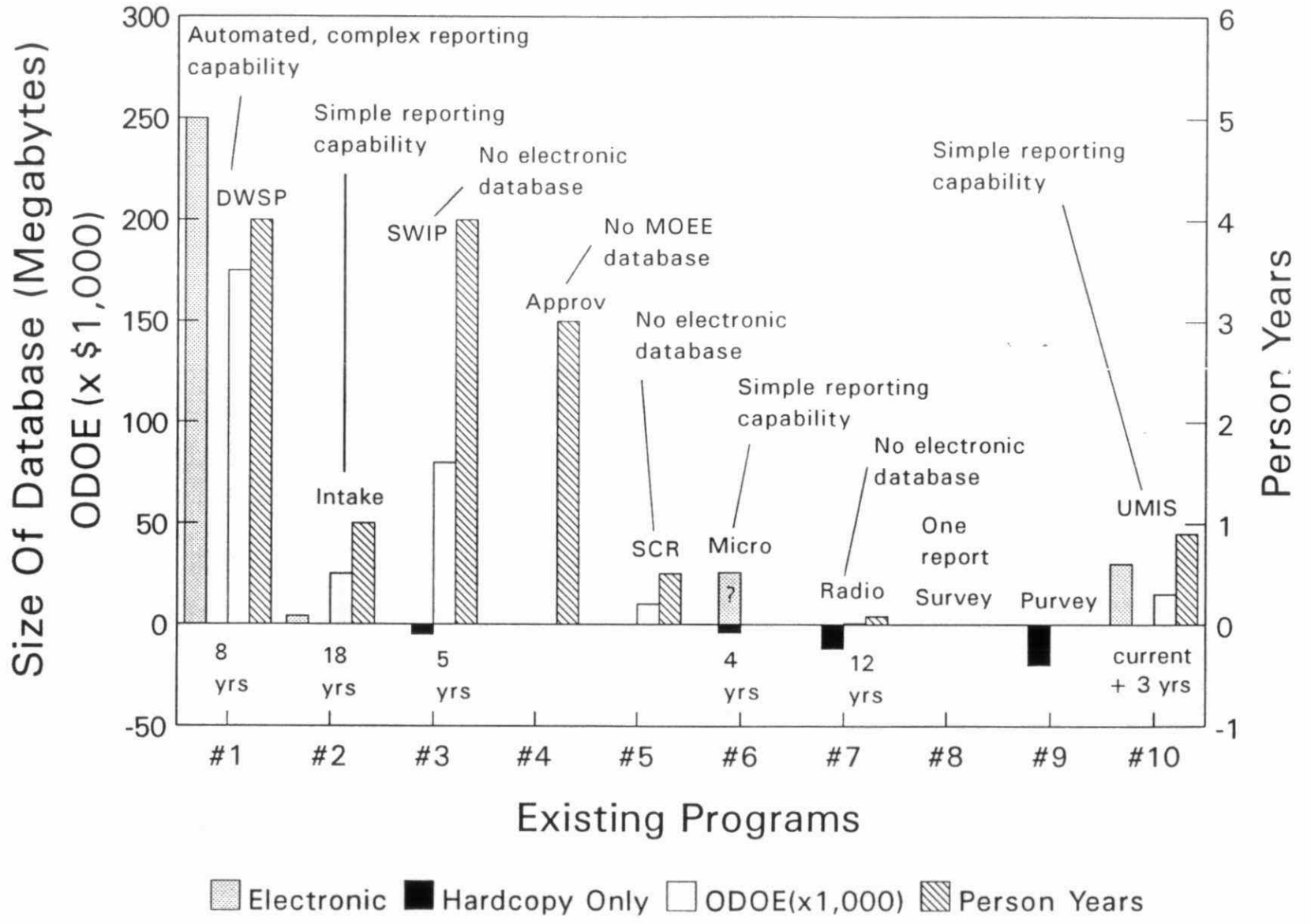
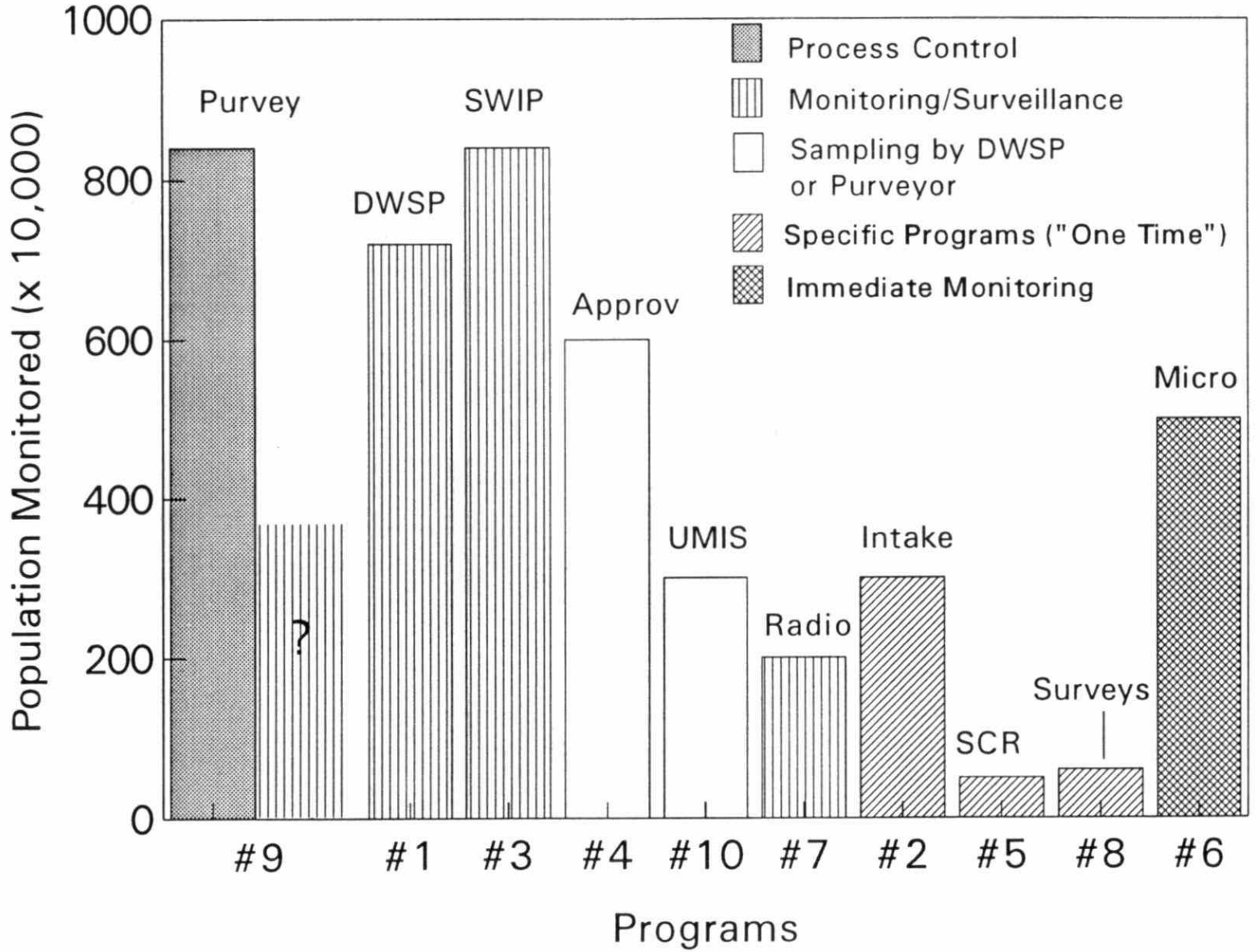


Figure 6. Grouping Of Programs



5.2 Needed Monitoring Programs

5.2.1 Mandatory

It is the responsibility of purveyor to achieve the terms and conditions of the C of A including the monitoring program.

5.2.2 Required for Safe Drinking Water

Monitoring of drinking water quality is just one of several considerations that must be addressed to ensure safe drinking water. Since typical grab samples only reflect the quality at that moment and raw water quality and treatment processes are dynamic functions, it is necessary to do more than just monitor. Thus it is the responsibility of the purveyor to ensure:

- source water protection,
- operator certification,
- treatment system control,
- distribution process control, and
- conformance with ODWOs.

5.2.3 Data Needs Within MOEE Branches

All MOEE branches that deal with various aspects of drinking water require appropriate knowledge about the production, regulation, monitoring and public reporting of drinking water. More detailed knowledge, that frequently includes monitoring data, is required to adequately address complex technical issues. The following are identified needs for MOEE:

APPROVALS - REGIONAL OPERATION DIVISION

- database for raw water and treatment characterization
- background of provincial monitoring to put above in context
- data gathered from proponent and MOEE monitoring programs

ENVIRONMENTAL MONITORING AND REPORTING BRANCH

- ground water quantity and quality
- near shore data
- new contaminant identification
- long-term trends
- extensive data requests from MOEE and outside users
- DWSP reports

PROGRAM DEVELOPMENT BRANCH

- risk management (historical and current data)
  - specific parameter quality
  - treatment process efficiency
  - support policy development
  - trends for policy prioritization

MOEE REGIONS

- audit compliance and conformance to ODWOs
- audit remedial activity
- corporate information
- data gathered from purveyors, DWSP (historical), SWIP

SCIENCE AND TECHNOLOGY BRANCH

- treatment process efficiency, optimization
- background monitoring (raw and treated)
- technology assessment

STANDARDS DEVELOPMENT BRANCH

- treated and distributed water quality data for:
  - risk assessment and management for existing and emerging contaminants
  - exposure data
  - standard setting through Federal/Provincial Subcommittee on Drinking Water

UPPER MANAGEMENT

- decisions that can have potentially significant human health effects and enormous economic impact should be based on sound data that adequately represents the issue

5.2.4 Data Users External to MOEE

- support to Medical Officer of Health and Local Health Units
- universities, Federal government for health related studies
- consultants
- industry
- public

5.2.5 DWSP Satisfies Data Needs

The Drinking Water Surveillance Program (DWSP) was developed during the years 1984 to 1986 to address a series a questions that were being repeatedly asked about the drinking water quality in Ontario and to form the basis for policy and program decisions. Prior to DWSP, the data was scattered throughout the province and only available in hardcopy. The most negative aspect associated with this limited data was the extreme variability in quality. There was no way to distinguish between good data and bad data.

DWSP was a new concept developed with all the basic fundamentals built into the program. The results of any testing are only as good as the sample it represents. An incorrectly taken sample will not reflect the true quality of the medium being sampled and can result in a gross misinterpretation of the situation. DWSP was designed to ensure that proper samples would always be taken and with the assessment information, results could be properly interpreted in the context of treatment processes and sampling conditions. Consistent analytical methods are used and the results are stored on a centralized database. Numerous and consistent quality checks

are made through all stages of data acquisition and storage to ensure dependable high quality data. The results are compared, electronically, to the ODWOs and standards from other agencies and exceedances are flagged. A parameter reference file was established for each parameter tested to aid in the interpretation of results.

Since 1986, DWSP has continued to develop and expand to better answer the questions that are still being asked. Historical data have increased the confidence in the answers. In 1986, there were 22 locations being monitored and now there are 130 with no increase in lab load allocation. The sampling frequency and parameters requested are now much more tailored to the type and location of the raw water source and the data history.

The DWSP database has continued to expand and with expert programming can produce a vast array of reports and information concerning provincial drinking water quality. As the quality of the DWSP database becomes known, more people working in the drinking water field, from consultants to university researchers, are requesting data.

5.3 Confidence in Data Quality

Data quality is related to the sampling and analytical methods, data management techniques and the quality checks through the process. Confidence in that data is also related to the amount of additional information that can be linked to it; this includes historical as well as current results. Single results on their own, even with the best sampling and analytical protocols etc., instill low confidence. If a compound is found **or not found** in the raw, treated and distributed water, when looking at the same block of water, confidence in the result is greatly increased. When examining a water supply as little as 2 to 4 times per year, it is important to acquire data with as much confidence as possible. For example, non-detect (ND) analysis do add considerable confidence to the interpretation of the data. Non-detects, as part of monitoring for ODWOs by either purveyors (C of A), SWIP or DWSP are often inevitable, since all municipalities obtain background "compliance" data.

Since "scans" are used by the laboratory to group certain compounds, i.e., PAHs, results are often obtained for non-target parameters. Many of these are "non-detects" (ND). Table 3 indicates the breakdown of parameters by scans.

Table 3. Breakdown Of DWSP Parameters By Scan.

DWSP SCAN	TESTS BY SCAN (A)	ODWOs (B)	ADDITIONAL PARAMETERS OF CONCERN (C)	"EXTRA" PARAMETERS A-(B+C)
Chemistry	23	16	2	5
Metals	25	15	6	4
Bacteriological	4	3	1	
Volatile Organics	31	15	4	12
Organics	37	14	6	17
Specific Pesticides	21	5	6	10
Triazines	13	7		6
Chlorophenols	12	5		7
PAHs	17	1	4	12
Radionuclides	7	5	1	1
Total	190	86	30	74

Non-detect results are also due in part to the relatively high detection levels for the analysis methods used. Other programs, e.g. Great Lakes Surveillance, can detect parameters not found by DWSP due to large volume concentrating techniques. Such procedures would be inordinately costly and probably not necessary for drinking water where ODWOs are often several orders of magnitude above the present detection levels.

However, confidence can also be obtained from previous data e.g. if a contaminant has historically been found in a certain well with several samples to confirm its presence, a single sample will indicate if the contaminant is still in the water. The effect of some specific sample reductions are discussed below.

To depict the matter of confidence in the data for answering Ministry needs, as encapsulated in typical questions, a graph, Figure 7, was developed. It represents the change in certainty in answering typical questions, such as compliance and treatment efficiencies, when changes are made to the existing sampling programs. For this example, the changes were "no raw" and "no distributed" and "1 sample/yr". Table 4 summarizes the expected effects on DWSP of a few possible sample site reductions.

The confidence rating was established by weighing all the factors of the various monitoring programs, both positive and negative, which are outlined in the introduction and assigning a percentage between zero and one hundred.

From the graph, a few examples indicate the effect on confidence with certain sample reductions:

1. With no raw water sample, there is a lack of information for treatment processes to be optimized. Plant efficiency and process control are not measured. Ambient water quality data are missing. If a parameter of concern is detected there is no confirmation from the raw water.

2. When only one sample per year is taken, confidence answering all the questions is markedly reduced. The impacts of seasonal changes can not be addressed. This is very important for parameters such as trihalomethanes (THMs) which can vary dramatically during the year. Figure 8, from 1993 DWSP data, explains the issue.

3. When no distributed sample is taken, there is no information on exposure to metals like lead.

6. Needs, Linkages and Gaps

6.1 General

With regard to the drinking water **source:**

Surface/groundwater quality monitoring programs and the drinking water monitoring program need to be integrated in a manner which facilitates decision making re: abatement/treatment needs and minimizes redundancies in monitoring (e.g., near shore surface water monitoring efforts could use drinking water source monitoring information, trends in source water quality can be used to determine abatement options or treatment options depending on the nature of the contamination and the source).

In the **treatment** area:

There is a need to review how decisions are made re: list of parameters for monitoring and frequency.

There is a need to build-in future capacity for monitoring of new contaminants which may arise from the source or from treatment processes.

In **distribution:**

As discussed under "treatment" judgement is required both in determining the list of parameters and frequency of monitoring. Increased monitoring may be needed to assess contaminants properly from the distribution system, e.g., antimony from solder, alkyltins from PVC pipe.

Figure 7. Confidence Level With Sample Reduction

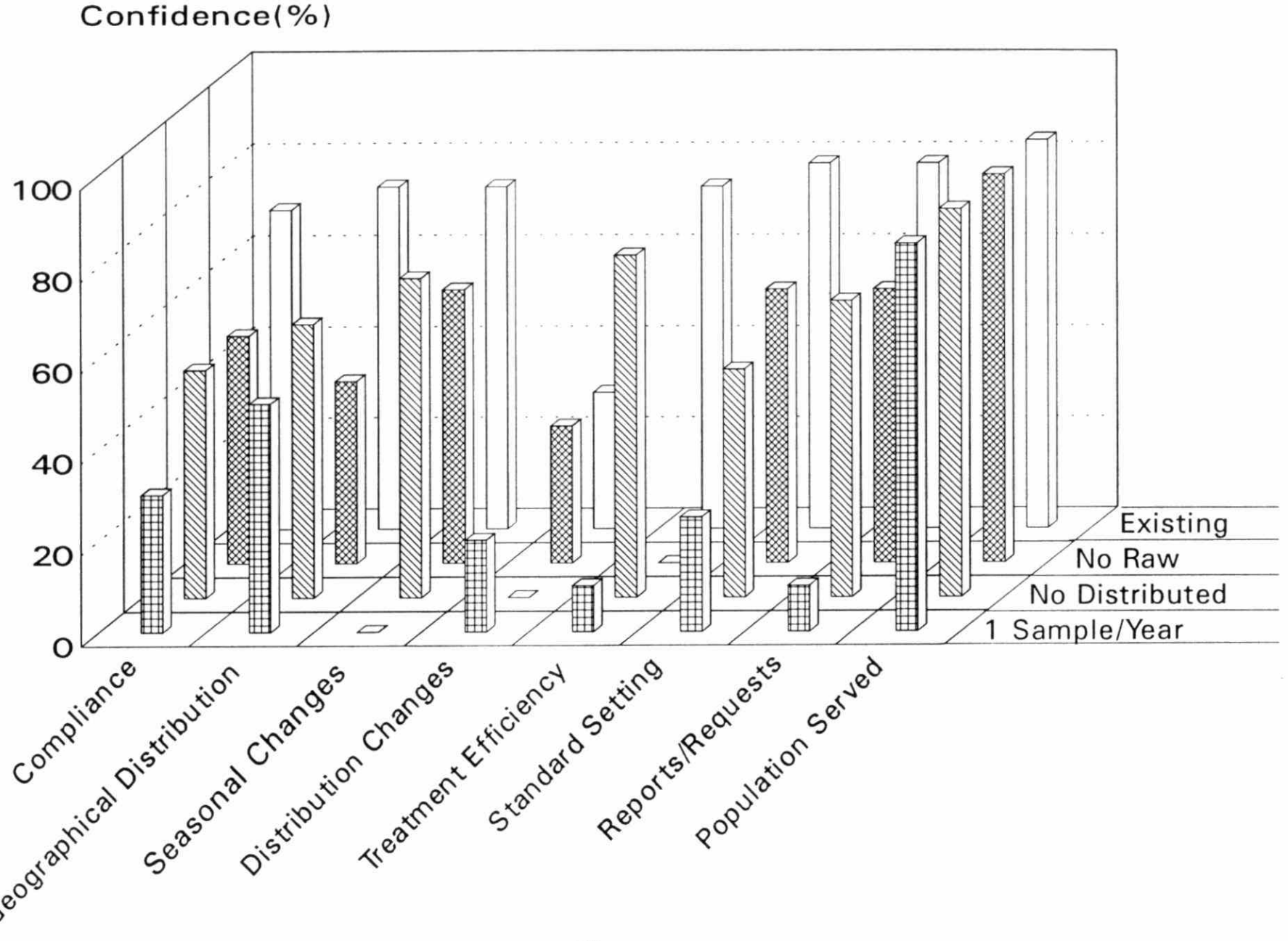
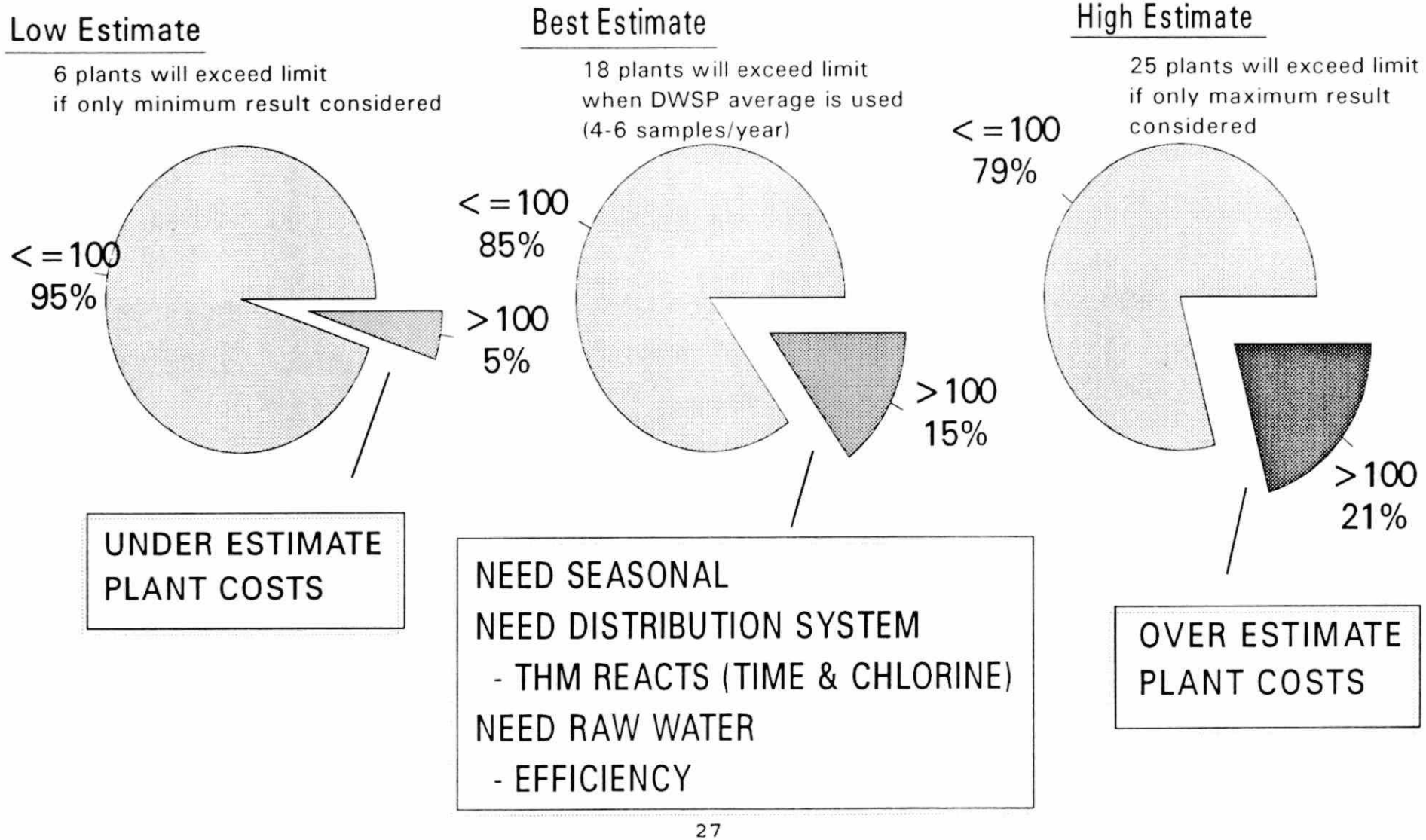


Table 4. Effect On DWSP By Decreasing Sample Sites.

EXISTING With No Raw	EXISTING With No Distribution	EXISTING With Only 1 Sample Set / Year
•lower confidence on treated water data •no ambient water quality data •no treatment efficiency •less information on source of contamination	•lower confidence on treated water data •no exposure data on metals (lead, copper, antimony) •no accurate exposure data on THMs •no information on impact of distribution system on water quality •no information on bacterial regrowth	•DWSP only audits •lose confidence in quality of product •no trend analysis •very limited exposure data •lose process efficiency •lose historical data •lose seasonal changes in water quality •no meaningful reports •would take 10 years to add on all locations with existing staff •1 sample/year - operator would lose sampling expertise
LOSE 40% OF DWSP's FUNCTIONS	**LOSE 25% OF DWSP's FUNCTIONS**	**LOSE 90% OF DWSP's FUNCTIONS**

Figure 8. Number Of Municipal Water Supplies Exceeding A Proposed THM Limit Of 100 ppb



There is a need for continued coordination of analytical and standards support. In addition, capacity needs to be made available to undertake analytical development and monitoring programs for "new" chemicals that have been identified for assessment in drinking water.

6.2 Program Gaps

Approvals/C of A
- comprehensive monitoring in C of A for about 150 of 500 municipal water supply systems
- data requested limited to ODWO parameters
- unknown if regional evaluation of data (except by SWIP) as specified in C of A
- no electronic database for data requested from purveyor

DWSP
- monitoring 130 of 500 municipal water supply systems
- very few houses in each system sampled
- more samples at consumer's taps are needed for exposure data
- some sampling restricted due to limited MOEE lab capacity

SWIP
- inspections at all 500 municipal systems but limited to once every 2 to 4 years
- no distributions system samples
- data gathered limited to some ODWOs at minimum sampling frequency
- no electronic database

UMIS
- limited to OCWA plants
- limited to a few parameters
- no data verification

RADIOLOGICAL
- limited to locations near nuclear facilities
- no database

6.3 Program Overlaps

There may appear to be substantial overlaps with the monitoring among the various programs, Figures 2, 3, 4 and 6, but in reality there is very little overlap due to the differences in frequency, type of sample and analyses requested. As a rule the purveyor only monitors when results are not available from DWSP.

In sampling drinking water to assess treatment processes, the raw and the treated must be sampled at essentially the same time (the same block of water). A raw water sample, taken even a short time later in some river supplies, would have no relationship to the treated water.

In some MOEE Regions, SWIP samples are taken when DWSP data are available.

The Radiological Monitoring samples intensively (weekly and monthly composite samples) near nuclear facilities, while DWSP takes grab samples once a year but on a province wide basis.

One program (water plant intake study) was not established to aid drinking water but to monitor ambient raw water quality trends from sample sites that were available year-round. This data are of very little use to the purveyor or DWSP since the number of parameters is so limited. Nor is DWSP data of much use to the intake study since the frequency of DWSP sampling is too low.

7. Options

Three options were developed for monitoring drinking water in the province that would still retain the outputs of an effective monitoring program. The main program in the options is DWSP, since it is the only comprehensive provincial program which addresses all aspects of monitoring as outlined in the introduction and the only program with a comprehensive database.

Table 5 lists the major monitoring programs and highlights the present capabilities of each program under the column heading "existing". The next 3 columns list three options which deviate from the existing to a greater or lesser degree. The impact on MOEE resources is assessed in Table 6.

In the **Existing** program, DWSP samples 130 of 500 municipal supplies for raw, treated and distributed water for up to 180 parameters 2 to 6 times per year. It has a complex electronic database, generates reports and customized requests. The municipal purveyor has its own information. About one quarter of all municipal supplies have Cs of A issued by Approvals which require site specific sampling for current ODWOs. SWIP inspects and samples 500 municipal supplies once in 2 to 4 years for the ODWOs. UMIS has monthly summaries on 14 chemical parameters from 113 OCWA plants. Radiological Monitoring is performed on 20 locations around nuclear facilities. MOH analyses bacteriological parameters for most locations. SCR and Surveys do site specific sampling and tests for specific parameters. The purveyor samples for process control, treatment efficiency, bacteriological and monitoring as specified in the C of A; additional monitoring may also be conducted especially at larger municipalities.

Option 1 contains minor changes to the existing program with no additional resources in the short term. Radiological and MOH data are made compatible with each other and DWSP. No locations are dropped from DWSP and 25 locations per year added over 15 years. DWSP takes over SWIP lab load allocation and enhances site specific

analyses and captures taste and odour complaint information. The municipal purveyor would keep its own data. An updated C of A for all municipal supplies would be phased in over 15 years. SWIP would continue inspections and audit C of A but take no samples. UMIS would continue with monthly summaries of 14 chemical parameters from 113 OCWA plants.

After 3 years MOEE resources would be affected, since DWSP would require up to 3 times current lab load allocation after 15 years.

In **Option 2** there are major changes in direction and for the most part no additional resources required. DWSP to drop 100 locations immediately and then add 25 new locations annually over 15 years. No more than 50 locations sampling regular DWSP parameters at any given time. This corrects the inequity of those plants, both large and small, now on DWSP receiving free analysis while the others must pay. Plants dropped would not be sampled again on DWSP except for exotic parameters (i.e., radiological, GC/MS characterization, new parameters). The municipal purveyor will be in a partnership with the MOEE and would sample for ODWOs when DWSP stops sampling. Data would be captured on the DWSP database when data of acceptable quality. C of A would be updated to include the appropriate monitoring program to increase confidence and all supplies phased in over 15 years as in Option 1. SWIP to continue inspections (every 2 - 4 years) and audit C of A using DWSP results. UMIS phased out and automated MBR reports done by DWSP. Radiological data and MOH non compliance data to be made available to DWSP.

Resources would be required for private laboratory accreditation and necessary QA/QC to ensure purveyor data of comparable quality to DWSP data.

Option 3 contains a major change in direction with substantial additional resources required resulting in greater confidence in a shorter time period. DWSP to drop 100 municipal supplies immediately and add 100 new supplies annually. DWSP would conduct intensive sampling for two years before dropping a location. All locations would rotate onto DWSP on a 6 year cycle. The municipal purveyor would be in a partnership with the MOEE. The purveyor samples the ODWOs when not sampling on DWSP and MOEE continues to sample for the exotic parameters. QA-QC would be required for this partnership. C of A altered to increase confidence as in option 2 and all locations phased in over 5 years. SWIP to increase to yearly inspections; would use data from DWSP and purveyor. UMIS phased out and automated MBR reports done by DWSP. Radiological data and MOH non compliance data to be made available to DWSP.

Substantial resources would be required by all MOEE areas dealing with drinking water.

7.4 Preferred Option and Why

The confidence rating is established by weighing all the factors of the various monitoring programs, both positive and negative, which are outlined in the introduction and assigned a score between zero and one hundred.

A histogram of the confidence level of the existing monitoring programs and the three options when typical questions are asked is shown in Figure 9.

In general Option 1 provides the most confidence in answering questions. The data quality is assured since it is a continued expansion of what is done now with analyses performed exclusively by the MOEE and MOL laboratories. Some additional resources would be required but not in the short-term.

Option 2 puts the burden of compliance for the ODWOs on the purveyor and this could be onerous for small municipalities. There are potential problems and additional resources associated with private lab accreditation, QA/QC for purveyor's data and software links.

Option 3 has the drawbacks of Option 2; provides better information faster; but has substantial additional resources. Since locations are revisited by DWSP, data would be acquired at least every 6 years even if the purveyor does not buy into the MOEE/purveyor partnership.

While at the present time Option 1 is the preferred choice, Option 2 with the Purveyor complying with a Certificate of Approval with a sampling frequency similar to the site/seasonal specific sampling optimisation of the DWSP could eventually become as viable.

To reach this point, there are a number of steps to address:

- Having the Purveyor accept the monitoring requirements of an expanded C of A; the analyses are an additional cost - especially for small utilities.

- Certification of external Laboratories by MOEE before data are accepted into an MOEE database, and following on with the required QA/QC for incoming data. This latter MOEE responsibility was a major budgetary and PY resource commitment for MOEE.

- Development of the necessary software links to the Purveyors.

The next chapter, Chapter 8, suggests a future vision for Drinking Water Monitoring and Option 2 can be considered as a first step toward this.

To achieve Option 2 viability a Feasibility Study is suggested which would include 3 Water Treatment System: two large (one run by a Public Utility and one by a Municipality) plus one small utility, for two years. This would establish the feasibility of achieving all the requirements in the steps listed above and develop costs and recommend timeframes.

Additionally, the monitoring of ODWOs by the Purveyor, a requirement of "compliance", would reduce the number of non-detects currently shown as part of the DWSP.

8. Future Program - a Vision for Monitoring

The concepts developed for the Drinking Water Surveillance Program in the mid 1980s still represent a solid foundation of the first principles for a future monitoring system.

A drinking water monitoring system must contain valid data, readily retrievable, and be able to ultimately include all municipal supplies in the province. Such a monitoring system must provide:

- immediate, reliable, easily accessible, understandable current water quality information in context with the treatment process;
- a flagging mechanism for exceedance of water quality objectives;
- a definition of contaminant levels and trends;
- a comprehensive database for remedial action;
- a framework for the assessment of new contaminants;
- an indication of the efficiency of plant processes.

The following requirements are an integral part of a good database:

- a sound sampling protocol to ensure the sample is representative of the water (reliable, standardized, documented procedures);
- sound analytical protocols (reliable, standardized, documented);
- a high degree of quality control of information entering the database.

Information systems must be versatile enough to accept variation in locations, parameters, and sampling frequency. The database must be usable by several levels of clientele.

Table 5. Monitoring Options.

PROGRAM	EXISTING	OPTION #1 (Minor Change)	OPTION #2 (Major Change) (No Additional Resources)	OPTION #3 (Major Change) (With Additional Resources)
DWSP	•no locations dropped •130 locations, more added as sampling reduced	•no locations dropped - still monitoring 7 million people in Ontario •add more locations •goal to add all locations with population > 500 people •able to add 25 locations/year - 15 years to add all locations	•100 locations dropped immediately •about 50 locations on DWSP at any one time •25 locations added annually •15 years to get all locations on program •frequency up to monthly for 2 years •plants dropped permanently from DWSP after 2 years sampling (ie., will not be put on DWSP again)	•100 locations dropped immediately •100 new locations added annually •locations dropped after sampling 2 years •all locations rotate on DWSP on 6 year cycle
	•2 years intensive sampling to gain background •minimum sampling: - 4-6/year surface supplies - 2-3/year groundwater •raw, treated and distributed samples •180 parameters - some site specific sampling	•add SWIP lab load •estimate insufficient lab capacity when 200 locations on line, require 3x lab capacity to add all locations •enhance site specific analysis to reduce number of NDs	•add SWIP lab load •when location not on DWSP, purveyor does ODWOs •DWSP does exotic parameters at all locations after sampling on DWSP for 2 years	•add SWIP lab load •when location not on DWSP, purveyor does ODWOs •DWSP does exotic parameters at all locations
	•central database •GIS compatible data	•capture taste and odour / complaints information	•capture taste and odour / complaints information •no purveyors' data added to DWSP until comparable data quality achieved	•capture taste and odour / complaints information •no purveyors' data added to DWSP until comparable data quality achieved
	•130 technical annual reports	•new reports: - 1 page summary/plant/year - overview	•new reports: - 1 page summary/plant/year - overview	•new reports: - 1 page summary/plant/year - overview
Municipal Purveyor	•monitoring for process control, treatment efficiency and as specified in the C of A •larger municipalities participating •some Regions request yearly ODWOs •unknown frequency and # parameters •unknown database	•data kept by purveyor	•purveyor does ODWOs as per CofA except when location on DWSP •partnership developed with MOEE to get purveyors' data on DWSP compatible database •pilot study at 3 municipalities	•same as OPTION #2

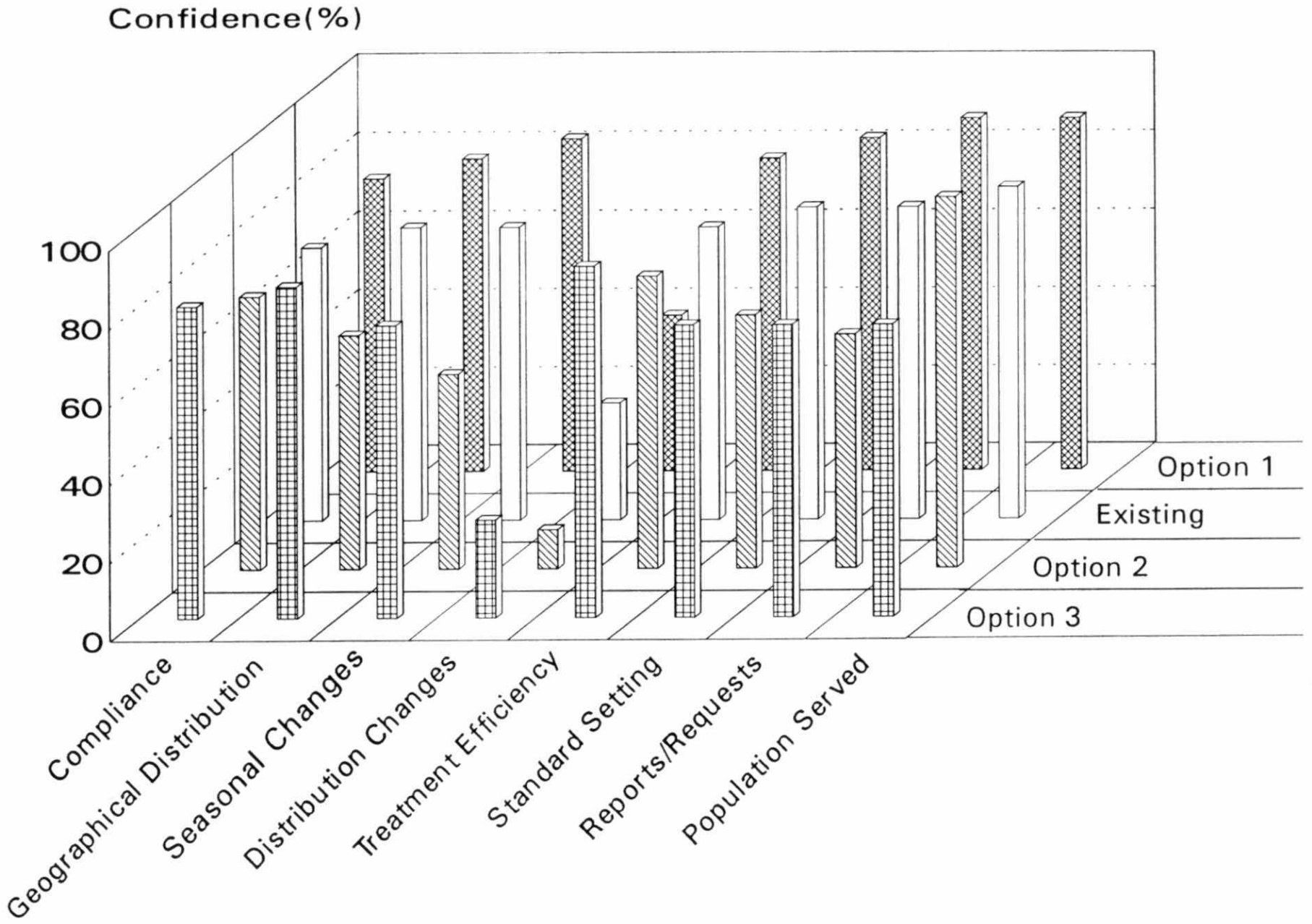
PROGRAM	EXISTING	OPTION #1 (Minor Change)	OPTION #2 (Major Change) (No Additional Resources)	OPTION #3 (Major Change) (With Additional Resources)
Approvals CofA	•about 150 municipalities have CofA with monitoring requirements •mandatory sampling by purveyor or DWSP as per CofA •site specific analysis and frequency •no database •evaluation conducted by regions	•update CofA for all municipal supplies phased in over 15 years	•same as OPTION #1 but may take more time •C of A updated to include appropriate monitoring program to increase confidence	•update CofA for all locations phased in over 5 years
SWIP	•inspects and samples all 500 municipal systems •one set of raw and treated every 2-4 years •20-150 parameters •evaluate CofA monitoring •no database •reports use data from SWIP and DWSP	•all locations •no sampling if on DWSP •inspects once every 2-4 years •evaluate / audit CofA sampling and results •reports use DWSP data	•same as OPTION #1	•<u>yearly</u> inspection at all locations
UMIS	•113 OCWA facilities •14 parameters sampled by purveyor •mainframe database •GIS compatible •monthly data summaries •Management By Results (MBR) reports	•same as EXISTING	•phase out •automated MBR reports by DWSP when data available	•same as OPTION #2
Radiological	•20 locations near nuclear facilities •only radiological parameters •weekly / monthly composites •no database	•make results on database compatible to DWSP	•results added to DWSP database	•same as OPTION #1

PROGRAM	EXISTING	OPTION #1 (Minor Change)	OPTION #2 (Major Change) (No Additional Resources)	OPTION #3 (Major Change) (With Additional Resources)
MOH	•microbiological analyses required by CofA and ODWOs •most locations •evaluated by Region •data used by UMIS •no database	•non-compliance data to Regions •electronic database compatible to DWSP •database kept by Regions	•same as OPTION #1	•same as OPTION #1
SCR and Surveys	•variable locations and sampling •no database	•data on database	•same as OPTION #1	•same as OPTION #1

Table 6. Monitoring Option Resources.

PROGRAM	EXISTING	OPTION #1 (Minor Change)	OPTION #2 (Major Change) (No Additional Resources)	OPTION #3 (Major Change) (With Additional Resources)
DWSP	•4 person years •$ 175K ODOE •dropping raw or distribution sample no effect on resources •to add all locations	•eventually insufficient lab load / capacity •same # people •extensive programming to upgrade operating system	•adequate lab load presently •same # people •extensive programming to upgrade operating system	•4 more people required to add locations and maintain / upgrade database system •major expansion in operating system •DWSP covers ~50% of analyses costs but equalized across all locations •must develop computer software
Municipal Purveyor	•not applicable	•not applicable	•not applicable	•must obtain computer hardware and software •purveyor must pay for ODWO analyses when not done by DWSP (4 out of 6 years)
Approvals C of A	•3 person years	•no change	•additional resources may be required or updated C of A phased in over >15 years	•additional resources required
SWIP	•4 person years	•no change	•no change	•additional resources required
UMIS	•0.9 person years	•no change	•no change	•not applicable (since phased out)
Radiological	•0.08 person years	•no change	•no change	•no change
MOEE Lab	•approximately 30 person years for drinking water samples	•no change •after 3 years DWSP would require increasing lab capacity	•major QA/QC resources to accredit private laboratories **Major problem with this option !**	•major QA/QC resources to accredit private laboratories

Figure 9. Confidence To Answering Questions



A number of driving forces at work in the water industry dictate the need for a new approach to the application of drinking water quality monitoring in Ontario. Some of these driving forces are:

1. Consumer Awareness and health concerns
2. Environmental protection awareness
3. Increasing number of water quality objectives/regulations.
4. Regionalization of supplies
5. Economics (working "smarter")
6. Technological advances in analytical and data technologies
7. Increasing amount of information.

It is estimated that 90% of the data produced on health related and aesthetic physical, chemical and biological parameters of drinking water in Ontario is produced outside of MOEE, by municipal laboratories, private laboratories, laboratories of other ministries, and on-line process control instrumentation.

It is further estimated that the 10% of the data generated by MOEE, specifically by DWSP, represent an overwhelming 80-90% of the reliable, readily accessible, and current information on drinking water in the province.

Drinking water information is collected for a variety of reasons, such as process control, distribution control, C of A or ODWO compliance, and investigation. Today, the data generally serve these primary purposes, but are then lost to the secondary uses of long term trending, assessment support and long term fine tuning of the process control & compliance monitoring needs.

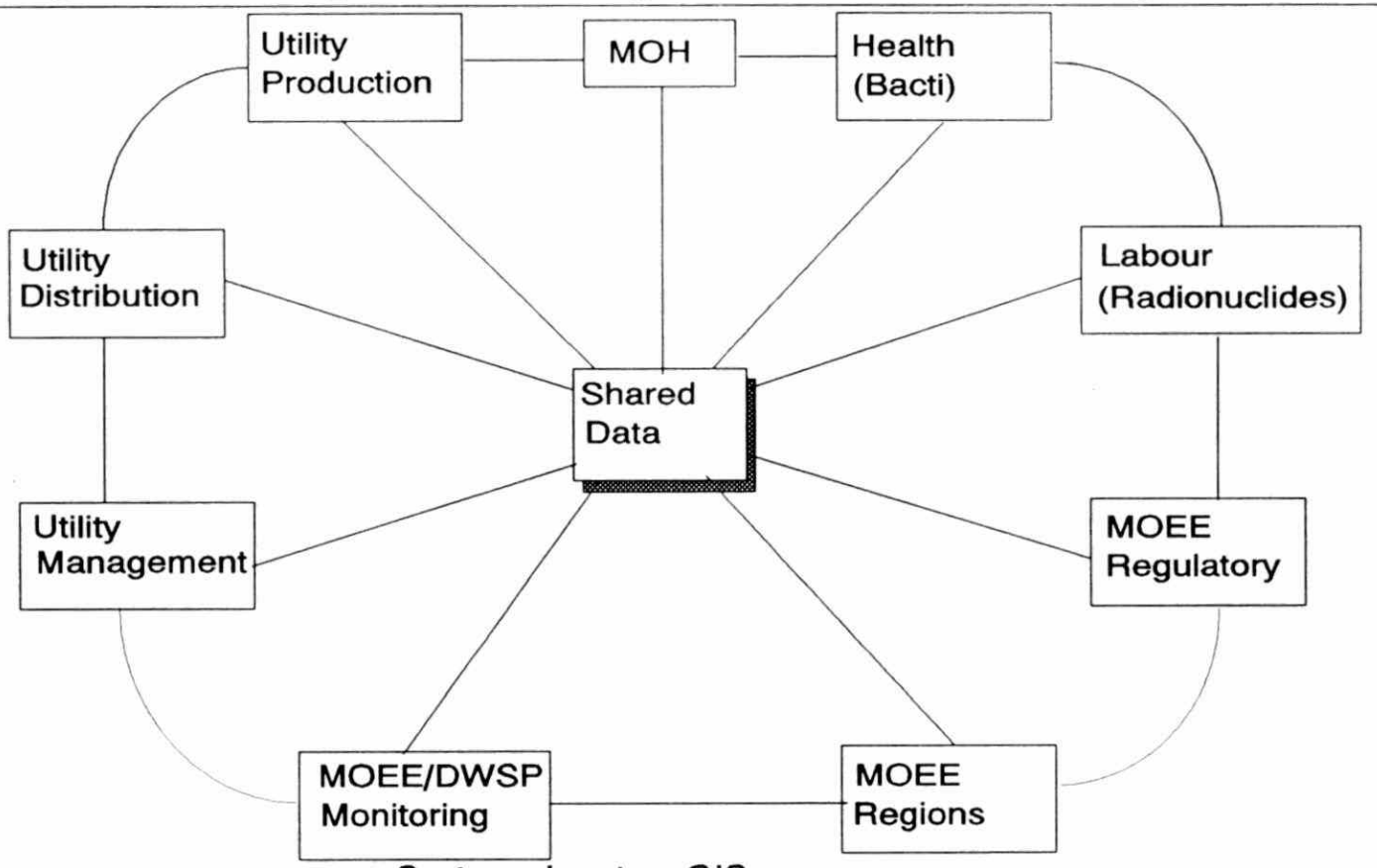
It is not practical from an information management or a logistical point of view to have all of the over 500 municipal water supplies use one large database for all of the information collected in water supply. It is therefore important to maintain high quality information by various primary data producers, such as the utilities, the MOEE, and other ministries (e.g., Health) in distributed databases.

A conceptual diagram of such a system, Figure 10, would allow sharing of information between utilities, MOEE, the Medical Officer of Health, and other stakeholders. The type of information on each specific system itemized below:

MOH
- private well investigations
- bottling plant inspections

Health (Bacti)
- private well / supply
- water plants

Figure 10. Integrated Drinking Water Monitoring Program



Systems Inputs: - GIS
- LIMS (MOEE, Utility, Private)
- On-line instruments
- Database

Labour (Radionuclides)
- analytical

MOEE Regulatory
- Certificate of Approval (CofA)
- Ontario Drinking Water Objectives (ODWOs) at municipality
- Director's orders

MOEE Regions
- inspections information
- compliance with CofA
- permits to take water
- variances granted from policy

MOEE Monitoring
- DWSP
- treatability / investigation
- reporting

Utility Management
- budget control / pricing
- maintenance / repair
- upgrading / new design
- personnel training
- Ontario Clean Water Agency

Utility Distribution
- inspections
- water mains flushing
- valve maintenance
- testing

Utility Production
- operator certification
- management expertise
- process control
-(turbidity, chlorine, flows, chemical doses)

Systems Inputs:

- GIS
- LIMS (MOEE, Utility, Private)
- On-line Instruments
- Databases

This approach would address all of the goals identified (e.g. Compliance, Process Control, Assessment, & Long-Term Trends), and do so in a cost effective manner. It is important to note that such distributed information systems will require considerable effort and potential cost at the outset to ensure comparable data.

Change is most positive when built on strengths, and DWSP is that strength. After 10 years of operation, DWSP is still leading the world in drinking water information systems.

The first step in the building process is to develop an Integrated Information System Plan which would identify the objectives and needs of database users and align them with the information and communication systems available.

Ontario is a world leader in drinking water database development (DWSP) and this Integrated Drinking Water Monitoring Program would not only lead to future technical and scientific leadership, but also to the potential for marketing to other jurisdictions worldwide.

9. Recommendations

1. In order to achieve the optimum confidence regarding the safety of drinking water to answer the typical questions and needs of MOEE Branches/Divisions **OPTION 1** is recommended.

2. MOEE should consider a Feasibility Study leading toward adoption of **OPTION 2**.

3. MOEE should accept, and explore further, the concepts suggested in the Chapter on the Future Program - A Vision for Monitoring; this is essentially a continuance of Option 2 with the various distributed databases being accepted, possibly after further Feasibility Studies, for MOEE use and analysis.

Appendix II

Program Tables

Appendix II

Goals\Program--> V	Drinking Water Surveillance Program (DWSP) #1	Water Plant Intake Monitoring (Intake) #2	Sewage & Water Inspection Program (SWIP) #3	Certificate of Approval Program (Approv) #4	Specific Contaminant Response (SCR) #5	Microbiology (MOH) (Micro) #6	Radiological Data (Radio) #7	Special Surveys (Surveys) #8	Purveyor Monitoring (Purvey) #9	Utility Monitoring Information System (UMIS) #10
COMPLIANCE	▸Yes •data used by OCWA, municipalities, and other operating authorities for compliance for C of A requirements •used by EMRB to alert MOEE and operating authority of ODWO health exceedance	▸No •only sample raw data	▸Yes •yearly samples are used as audit of plant results •evaluation of compliance with C of A where available	▸Yes •C of A specifies required monitoring program •data evaluation ?	▸No •except indirectly if parameter has ODWO	▸Yes •primary testing program for microbiological quality for municipal, communal and private water systems	▸No	▸Disinfection Byproducts Survey (DBP): No ▸1st Nations Drinking Water Survey (1st Nat) : Yes •brief survey to assess compliance by Health Canada	▸Yes	▸Yes •but for very limited number of parameters •only for OCWA operated water plants
PROCESS CONTROL Note: Program to identify in-plant monitoring may need to be added.	▸Yes •audit of all treatment process efficiencies	▸No	▸Yes	▸Yes •C of A requires some process control monitoring	▸No	▸Yes •Microbio-logical results used to access disinfection	▸No	▸No	▸Yes	▸Yes •some parameters can be used to audit some treatment processes
LONG-TERM TRENDS AND EARLY WARNING INDICATORS IN RAW AND TREATED DRINKING WATER QUALITY	▸Yes •able to easily look at long term trends •rapid and flexible reporting •limited to 130 municipal water plants	▸Yes •weekly data on raw water quality •only 22 surface water plants •limited parameters (general chemistry and algae)	▸No •potentially possible if data in adequate database	▸No	▸No	▸Yes •limited to only microbiological parameters •limited reporting capabilities due to database inadequacies	▸Yes •limited to a few sites near nuclear facilities	▸No	▸Unknown	▸Yes •limited to OCWA plants •limited to a few general chemicals and physical parameters •limited reporting capability

Goals\Program--> | | | | V	Drinking Water Surveillance Program (DWSP) #1	Water Plant Intake Monitoring (Intake) #2	Sewage & Water Inspection Program (SWIP) #3	Certificate of Approval Program (Approv) #4	Specific Contaminant Response (SCR) #5	Microbiology (MOH) (Micro) #6	Radiological Data (Radio) #7	Special Surveys (Surveys) #8	Purveyor Monitoring (Purvey) #9	Utility Monitoring Information System (UMIS) #10
INVESTIGATIONS /STUDIES /SURVEILLANCE (More Programs?) --- - other regional monitoring? (ie., WC region sampling for NDMA) - health unit sampling for chemical analysis -municipalities, water plants and consultants (ie., organics at Toronto water plants)	▸Yes •able to detect new contaminants •able to do in-depth site specific monitoring •provides information for remedial measures •aids in developing and improving new sampling methods	▸No	▸No	▸No	▸Yes •in-depth site specific monitoring •limited to a few locations •usually limited to relatively short time period •develops appropriate treatment technologies	▸No	▸No	▸No	▸Unknown	▸No

COMPARISON OF MAJOR ITEMS IN EXISTING PROGRAMS

Appendix IIB

Description\ Program--> V	Drinking Water Surveillance Program (DWSP) #1	Water Plant Intake Monitoring (Intake) #2	Sewage & Water Inspection Program (SWIP) #3	Certificate of Approval Program (Approv) #4	Specific Contaminant Response (SCR) #5	Microbiology (MOH) (Micro) #6	Radiological Data (Radio) #7	Special Surveys (Surveys) #8	Purveyor Monitoring (Purvey) #9	Utility Monitoring Information System (UMIS) #10
COVERAGE:										
• # Facilities Monitored	▸130 municipal drinking water systems ▸surface and ground waters ▸more added each year	▸22 surface water plants	▸Province wide, all municipal and communal systems (approximately 500)	▸Water plants with C of A after 1985	▸Anywhere in province but limited to a few locations	▸All private supplies ▸most municipal and communal systems	▸Some water plants ▸primarily near nuclear generating/ research facilities	▸Disinfection Byproducts Survey (DBP): 2 to 3 locations in Ontario ▸1st Nations Drinking Water Survey (1st Nat): only Indian reservations	▸Approximately 500 municipal water supply systems	▸Only OCWA operated facilities
• Type Samples Taken	▸Raw, treated and distributed waters	▸Only raw water	▸Raw and treated waters	▸Raw, treated and distributed waters	▸Raw, treated and distributed waters	▸Raw, treated and distributed waters	▸Raw and treated waters	▸DBP: raw, treated and distributed waters ▸1st Nat: only treated water	▸Raw and treated waters, plus distributed bacteriological	▸Raw and treated waters, plus distributed bacteriological
• # Parameters Analyzed	▸About 180 taste and odour (2), bacteriological (4), field tests(6), general chemistry(24), metals(24), organics(131), radionuclides (7), exotics(3)	▸11 algae(1), general chemistry(10)	▸20 for audit of plant results ▸minimum sampling schedule for each water plant	▸As specified in C of A	▸Variable, site specific	▸3 bacteriological	▸10 radiological	▸DBP: Numerous chlorination by-products ▸analyzed by Health Canada	▸Variable and site specific	▸14 physical and general chemistry
• Frequency	▸Each facility - 2 to 12 times/year	▸Weekly	▸Every other year	▸As specified in C of A	▸Variable, site specific	▸As requested - 400,000/year	▸Weekly composite	▸One-time only	▸Variable	▸Monthly data summaries provided by water plants

COMPARISON OF MAJOR ITEMS IN EXISTING PROGRAMS

Description\ Program--> V	Drinking Water Surveillance Program (DWSP) #1	Water Plant Intake Monitoring (Intake) #2	Sewage & Water Inspection Program (SWIP) #3	Certificate of Approval Program (Approv) #4	Specific Contaminant Response (SCR) #5	Microbiology (MOH) (Micro) #6	Radiological Data (Radio) #7	Special Surveys (Surveys) #8	Purveyor Monitoring (Purvey) #9	Utility Monitoring Information System (UMIS) #10
DATA QUALITY:										
• Documented Protocols	▸Yes	▸Yes	▸Yes	▸Yes	▸Yes	▸Yes	▸Yes	▸Yes	▸Unknown	▸Yes
• Verification	▸Many steps involved to ensure valid representative results: •stainless steel sampling lines/taps •lab QA/QC •manual data perusal of lab sheets •automated system check •data check of reports	▸Unknown	▸Lab QA/QC ▸thorough review of results	▸None	▸Lab QA/QC ▸thorough review of results	▸Lab QA/QC	▸Lab QA/QC	▸Lab QA/QC	▸Unknown	▸None
• Quality Estimate	▸Excellent	▸Excellent	▸Good	▸Variable	▸Excellent	▸Excellent	▸Good	▸Good	▸Unknown	▸Acceptable

COMPARISON OF MAJOR ITEMS IN EXISTING PROGRAMS

Description\ Program--> V	Drinking Water Surveillance Program (DWSP) #1	Water Plant Intake Monitoring (Intake) #2	Sewage & Water Inspection Program (SWIP) #3	Certificate of Approval Program (Approv) #4	Specific Contaminant Response (SCR) #5	Microbiology (MOH) (Micro) #6	Radiological Data (Radio) #7	Special Surveys (Surveys) #8	Purveyor Monitoring (Purvey) #9	Utility Monitoring Information System (UMIS) #10
▸DATABASE/ REPORTING:										
•Database	▸Large, comprehensive database •8 years of data •250 megabytes	▸18 years of data ▸4 megabytes	▸No electronic database ▸3-5 years of data	▸No MOEE database ▸maybe available at individual plants	▸No electronic database	▸4 years electronic database	▸No electronic database ▸12 years of data	▸Unknown	▸Unknown	▸4 years of data ▸30 megabytes ▸only on mainframe
•Reporting	▸Complex reporting capability •individual annual reports -automated generation •special in-depth custom reports on request •extensive use of data by MOEE, MOH, other agencies and the public	▸Simple reporting capability •no specific reports generated •data used in other reports	▸Manual generation of a report per inspection ▸data used in other reports	▸Annual reports by water plants	▸Manual generation of a report on each item	▸Simple reporting capability ▸numerous data reports on individual samples	▸Yearly data dump	▸One report	▸	▸Monthly data summaries

COMPARISON OF MAJOR ITEMS IN EXISTING PROGRAMS

Description\ Program--> V	Drinking Water Surveillance Program (DWSP) #1	Water Plant Intake Monitoring (Intake) #2	Sewage & Water Inspection Program (SWIP) #3	Certificate of Approval Program (Approv) #4	Specific Contaminant Response (SCR) #5	Microbiology (MOH) (Micro) #6	Radiological Data (Radio) #7	Special Surveys (Surveys) #8	Purveyor Monitoring (Purvey) #9	Utility Monitoring Information System (UMIS) #10
RESOURCES ALLOCATED:										
• ODOE ($/year)	▸175,000 (*)	▸25,000	▸80,000	▸	▸10,000	▸	▸500	▸	▸	▸15,000
• Analytical ($/year)	▸1,800,000 @ cost $6/test	▸80,000 @ cost $6/test	▸60,000 (**) @ cost $10/test	▸	▸	▸	▸	▸	▸	▸
• PY	▸4 (*) (*) ODOE and PY for DWSP used to keep program running: -sample scheduling -bottles -downloading results into database -verification -reporting -adding new locations	▸1	▸4 (**) Note: some Regions do full DWSP analyses	▸3	▸0.5	▸	▸0.08	▸	▸	▸0.9

Appendix III

MOEE Approval Process

Appendix III

MOEE Approval Process

In Ontario, **The Ontario Water Resources Act (OWRA)** is the legislation that governs communal drinking water supply systems. Section 52 (OWRA) requires that approval be obtained for water works. It also states that the approving Director may grant approval on such terms and conditions as he/she considers necessary.

Section 52.(8), however, provides an exemption from approval under the OWRA to certain drinking water supply works as follows:

> **(b) to a water works not capable of supplying water at a rate greater than 50,000 litres per day;**
> **(c) to a privately-owned water works to be used to supply water only for five or fewer private residences.**

Water supplies not governed by the OWRA are the responsibility of local Health Units and individuals.

The MOEE Guideline B-5: "Drinking Water Quality" and the associated Procedure B-5-1: "Ontario Drinking Water Objectives (ODWO) deal with the protection and enhancement of drinking water quality, and are intended to protect public health and encourage the provision of aesthetically pleasing water. The Guideline B-5 states: "The quality of drinking water shall conform to the limits described in Procedure B-5-1: "Ontario Drinking Water Objectives" and "Adequate sampling and monitoring programs are to be undertaken for chemical, physical, radiological and microbiological parameters, to ensure compliance with required water quality criteria (Procedure B-5-1)".

Non-compliance with the MOEE Guideline B-5 is not, however, an offence per se. The actual application and enforcement of the "Ontario Drinking Water Objectives" quality criteria is through the approval procedure established under **The Ontario Water Resources Act**. Under this procedure, certificates of approval for communal drinking water supply system are issued with terms and conditions. A standard condition in all certificates of approval for drinking water supply system is:

> **The owner shall construct and operate the entire water supply and treatment system in such a manner, and with such facilities that water supplied to the consumers serviced by the system satisfies the water quality objectives, guidelines and requirements as set out in the publication entitled "Ontario Drinking Water Objectives" 1983, as amended from time to time by more recently published editions.**

The Municipal Approvals Section of the MOEE Approvals Branch administer the approval program for municipal and private water works under section 52 (OWRA) and through conditions on certificates of approval, specifies monitoring requirements based on recommendations contained in the Ontario Drinking Water Objectives document. The water quality monitoring program (number and frequency of parameters to be sampled and recorded) are stipulated on the certificate after assessing the raw water quality, water source (ground or surface), type of chemicals added for treatment purposes (chlorine, fluoride, alum etc.) and site specific conditions. When local conditions and existing data indicate that particular substances (e.g. radionuclides, pesticides known to be not used in the area of water supply, etc,) are consistently absent from a water supply or below level of concern, Approvals Branch, on recommendation of District Office may alter the number of parameter and/or frequency of sampling and parameters required for a monitoring program. The proponent may also request relaxation of the requirement for water quality analysis of some of the parameters contained in table 1 of the "Drinking Water Objectives". Such a request must be accompanied by supporting documentation.

Recently, as part of an Approvals Reform process to streamline review requirements, "Model" conditions for water treatment and supply systems have been prepared. Input received from the MOEE regional staff and other stakeholders regarding monitoring programs emphasize the need to allow flexibility on the number of parameters, frequency and reporting requirements subject to the discretion of the District Manager.

It should be recognized, however, that the provision of safe drinking water depends on numerous measures and actions that are intended to achieve good quality drinking water at all times. Such measures must be undertaken regardless of any specific drinking water quality limits. The certificate of approval with conditions covers five major aspects of any of water treatment and supply system:

- description of the processes and facilities that have been reviewed and approved, and must be used to treat drinking water;

- site and project specific performance criteria which define the approval basis (maximum flow, treatment process capacity etc.), as well as, delineating treated water quality requirements and residual waste disposal;

- operational and performance related monitoring and recording requirements;

- requirement for the level of operation and maintenance to be sufficient to meet the performance criteria including:

protection of water source, use of chemical additives, staffing and training, operational manual, complaints and notification etc.

- reporting procedures necessary to allow the owner, the Ministry and the public (upon request) to be kept informed of the operation and performance of the works as it relates to meeting the requirements of the certificate.

The assessment of performance of the water treatment and supply system based on monitoring and reporting requirements imposed by the certificate of approval goes beyond the compliance with numerical quality limits. Such an assessment as reported to the District Manager, in addition to compliance with ODWO, would include:

- a summary and discussion of the quantity of water supplied during the reporting period compared to the design values for the population serviced, including peak flow rates, maximum daily and monthly average flows;

- a summary and interpretation of analytical results obtained in accordance with monitoring and recording requirements of the certificate of approval (which would include the raw water quality);

- a tabulation and description of any emergency or upset conditions which occurred during the period being reported upon (zebra mussels control measures);

- a summary of the chemicals used in treatment processes with special reference to any abnormal usages.

The following identifies the gaps and needs of the mandatory drinking water monitoring program in Ontario:

<u>GAPS</u>

* The OWRA does not cover all drinking water supplies in the province;

* Only certificates of approval issued after 1985 have monitoring programs stipulated as conditions of approval. These vary in scope and comprehensiveness;

* Usually only certificates issued after the development of standardized "Model" conditions in 1991 have comprehensive monitoring programs;

* Majority of water supply systems do not have certificates with comprehensive monitoring programs;

* Almost all monitoring programs specified on certificates are different due to site specific conditions as well as, subsequent amendments to the number of parameters, frequency and reporting requirements;

* The monitoring requirements are deemed to be quite onerous for small water systems;

* During the on going process of consultation with stakeholders the "model" conditions specifying monitoring programs were subject to criticism by the Water Utility and Public Information Committee, AWWA, Ontario section for their significant cost;

* The Ministry, under its Drinking Water Surveillance Program (DWSP), is currently sampling over 125 municipal drinking water supply systems. This program satisfies the mandatory monitoring requirements imposed by certificates. Should DWSP be discontinued, the affected municipalities would face significant cost increase and may try to eliminate or decrease number of parameters and frequency of sampling;

* The monitoring programs may not pick up spills, periodic contaminations or tampering;

* There is some inconsistency in the approach to setting up monitoring programs as this depends on judgement of the review engineer in the Approvals Branch and environmental officer in the District;

NEEDS

* To review the balance between the necessary flexibility of site specific monitoring (population, cost, water source etc.) and its implications in actual practice;

* To focus research on development of bio-monitoring capable to react immediately to spills of toxic materials;

* To develop a guideline for establishing mandatory monitoring programs for water systems with varying population base and water source characteristics and potential for its contamination.

* To set a goal that each drinking water supply in Ontario has appropriate monitoring program.

Appendix IV

Sewage And Water Inspection Program (SWIP)

Appendix IV

SEWAGE AND WATER INSPECTION PROGRAM (SWIP)

COMPLIANCE MONITORING:

The appended minimum recommended sampling protocols (Tables I, II, and III) were compiled in 1993 and modified in 1994 by the M.O.E.E.'s Sewage and Water Inspection Program (SWIP) Coordinators in consultation with the Ministry's District Abatement Offices and Water Resources Branch.

The sampling protocols reflect recommendations made in the Ministry of Environment and Energy publication entitled: "Ontario Drinking Water Objectives", as revised in 1994. In the absence of "legally binding" sampling protocols dictated in some Water Works Certificates of Approval, District Office inspections staff use the appended sampling protocols in order to assess the comprehensiveness of an operating authority's sampling regime. In the reports prepared subsequent to water treatment plant SWIP inspections, it is recommended that the operating authority (where a more stringent Certificate of Approval dictated sampling program does not exist) adopt the use of the appended minimum recommended sampling protocol (Table I or Table II depending upon the source of the water supply).

The Table I and Table II sampling protocols (surface water and ground water supplies respectively) focus on the collection of treated water samples in order to the minimize analytical costs born by the operating authority. Raw water and distribution system sampling must be conducted in order to conform with the bacteriological monitoring recommended in the Ontario Drinking Water Objectives.

Physical/chemical, bacteriological, metals, pesticides, and trace organic and inorganic contaminant monitoring establishes the treated water's conformance with the Maximum Desirable Concentrations, Aesthetic Objectives, and Operational Guidelines stipulated in the Ontario Drinking Water Objectives. The existence of a comprehensive treated water monitoring program bolsters consumer confidence in the quality of the water supplied by the operating authority.

INVESTIGATIONS:

During the course of performing SWIP inspections the Environmental Officer collects samples for analysis. The analyses performed may be as broad as that outlined on the appended Table III, however, the inspector uses his or her judgement as to how comprehensive the sampling must be in order to support the inspection. Factors which the Environmental Officer weighs when deciding how comprehensive the SWIP inspection sampling must be

include any history of poor water quality associated with the project, the comprehensiveness of the operating authority's sampling regime, and conditions at the water supply during the inspection.

The Ministry's response to complaints regarding treated water quality typically involve consultation with the water supply's owner/operating authority during which the sampling program is discussed and the status of remedial actions is reviewed. Ministry staff may also review historical data to identify existing problems and remedial actions which are planned or underway to correct those problems.

In responding to complaints or when performing SWIP inspections it is the Ministry's goal to ensure that safe drinking water is supplied to consumers and that operating authority delivered monitoring programs are in place to support public confidence in the water supply.

TABLE I: COMPLIANCE MONITORING - SAMPLING OF DRINKING WATER BY THE OPERATING AUTHORITY

Surface Water Supplies

Frequency	Sample Type	Sampling location and notes	Parameters
Yearly	PHYS/CHEM Note: not required for DWSP Municipalities	Samples to be taken from all sources of entry to the distribution system. This means multiple samples for multiple supplies where a common treatment system and entry point to the distribution system are not used.	Table 2 - A (see attached)
Vulnerable Quarterly Not Vulnerable 1/10 Yrs.	PHYS/CHEM Note: not required for DWSP Municipalities	Samples to be taken from all sources of entry to the distribution system. This means multiple samples for multiple supplies where a common treatment system and entry point to the distribution system are not used.	Table 1 - A (see attached)
Yearly for 3 Yrs. - if no MAC's exceeded 1/3 Yrs.	PHYS/CHEM Note: not required for DWSP Municipalities	Samples to be taken from all sources of entry to the distribution system. This means multiple samples for multiple supplies where a common treatment system and entry point to the distribution system are not used.	Table 1 - B (see attached)
Not detected in 1st sample 1/5 years, if detected in 1st sample or if in vulnerable area- quarterly	PHYS/CHEM Note: not required for DWSP Municipalities	Samples to be taken from all sources of entry to the distribution system. This means multiple samples for multiple supplies where a common treatment system and entry point to the distribution system are not used.	Table 1 - C (see attached)
Yearly if vulnerable 1/5 years if not	PHYS/CHEM Note: not required for DWSP Municipalities	Samples to be taken from all sources of entry to the distribution system. This means multiple samples for multiple supplies where a common treatment system and entry point to the distribution system are not used.	Fluoride
Yearly unless in vulnerable[1] area- quarterly	PHYS/CHEM Note: not required for DWSP Municipalities	Samples to be taken from all sources of entry to the distribution system. This means multiple samples for multiple supplies where a common treatment system and entry point to the distribution system are not used.	Trihalomethanes
Quarterly	PHYS/CHEM Note: not required for DWSP Municipalities	**Treated Water** all entry points to the distribution system	Colour Alkalinity as CaCO3 Chloride as Cl pH Conductivity Aluminum if Alum used
Weekly	Bacteriological	**Treated Water** all entry points to the distribution system **Treated Water** in distribution system Population No. of Samples monthly <100,000 8 + 1/1,000 >100,000 100 + 1/10,000	Utilize MPN, MF or PA NOTE: frequency as per ODWO < 100,000 - weekly > 100,000 - twice per week

[1] Vulnerable if sample result is > 50% of MAC

Individual requirements may be added for specific plants when required.

Frequency	Sample Type	Sampling location and notes	Parameters
Daily	PHYS/CHEM	Treated Water	Turbidity Fluoride (if treatment provided) others as required (Aluminum)
Daily	PHYS/CHEM	Treated Water or Closest available consumer if no 15 Minutes retention in plant	Total Chlorine residual
As received	Record complaints	Consumers	Taste and Odour

TABLE II: COMPLIANCE MONITORING - SAMPLING OF DRINKING WATER BY THE OPERATING AUTHORITY

Ground Water Supplies

Frequency	Sample Type	Sampling location and notes	Parameters
Yearly	PHYS/CHEM Note: not required for DWSP Municipalities	Samples to be taken from all sources of entry to the distribution system. This means multiple samples for wells where a common treatment system and entry point to the distribution system are not used.	Table 2 - A (see attached)
Vulnerable Quarterly Not Vulnerable 1/10 Yrs.	PHYS/CHEM Note: not required for DWSP Municipalities	Samples to be taken from all sources of entry to the distribution system. This means multiple samples for wells where a common treatment system and entry point to the distribution system are not used.	Table 1 - A (see attached)
Yearly for 3 Yrs. - if no MAC's exceeded 1/3 Yrs.	PHYS/CHEM Note: not required for DWSP Municipalities	Samples to be taken from all sources of entry to the distribution system. This means multiple samples for wells where a common treatment system and entry point to the distribution system are not used.	Table 1 - B (see attached)
Not detected in 1st sample 1/5 years, if detected in 1st sample or if in vulnerable area- quarterly	PHYS/CHEM Note: not required for DWSP Municipalities	Samples to be taken from all sources of entry to the distribution system. This means multiple samples for wells where a common treatment system and entry point to the distribution system are not used.	Table 1 - C (see attached)
Yearly if vulnerable 1/5 years if not	PHYS/CHEM Note: not required for DWSP Municipalities	Samples to be taken from all sources of entry to the distribution system. This means multiple samples for multiple supplies where a common treatment system and entry point to the distribution system are not used.	Fluoride
Yearly unless in vulnerable[2] area quarterly	PHYS/CHEM Note: not required for DWSP Municipalities	Samples to be taken from all sources of entry to the distribution system. This means multiple samples for multiple supplies where a common treatment system and entry point to the distribution system are not used.	Trihalomethanes

[2]Vulnerable if sample result is > 50% of MAC

Individual requirements may be added for specific plants when required.

Frequency	Sample Type	Sampling location and notes	Parameters
Weekly	Bacteriological	**Treated Water** all entry points to the distribution system **Treated Water** in distribution system Population No. of Samples monthly <100,000 8 + 1/1,000 >100,000 100 + 1/10,000	Utilize MPN, MF or PA NOTE: frequency as per ODWO < 100,000 - weekly > 100,000 - twice per week
Daily	PHYS/CHEM	Treated Water	Turbidity * Fluoride (if treatment provided) others as required (Aluminum) * May be deleted with cause
Daily	PHYS/CHEM	Treated Water or Closest available consumer if no 15 Minutes retention in plant	Total Chlorine residual

Note: Two elements of this program (SWIP) which are different from the Ontario Drinking Water Objectives (ODWO), see below;

Nitrate, Nitrite, Nitrate + Nitrite - ODWO - quarterly
- SWIP - annually

Trihalomethanes - ODWO - quarterly
- SWIP - if vulnerable quarterly else 1/year

Individual requirements may be added for specific plants when required.

TABLE III: INVESTIGATION - MINISTRY OF ENVIRONMENT AND ENERGY MINIMUM INSPECTION PROGRAM WATER SUPPLIES

Frequency	Sample Type	Sampling location and notes	Parameters
Once every two years	PHYS/CHEM	Samples to be taken from all sources of entry to the distribution system (within reason). This means multiple samples for wells where a common treatment system and entry point to the distribution system are not used. Note: For systems with a large number of wells discretion must be used to make this reasonable.	Table 1 - A, Table 1 - B, & Table 1 - C Table 2 - A (see attached) Trihalomethanes Fluoride
Once every two years	PHYS/CHEM	Raw Water (optional when full treatment is provided)	Selected parameters of concern
Once every two years	Bacteriologic al	**Treated Water** samples from all entry points to the distribution system	Total and Faecal Coliform

MINISTRY OF ENVIRONMENT AND ENERGY MINIMUM INSPECTION PROGRAM TABLES

Table 1 - A

Alachlor	Aldrin + Dieldrin	Atrazine
Carbaryl	Carbofuran	Chlordane
Chlorpyrifos	Cyanazine	Diazinon
Dicamba	Diochlorodiphenyltri-chloroethane (DDT) + Metabolites	2,4 Dichlorophenoxyacetic-acid (2,4-D)
		Heptachlor + Heptachlor Epoxide
Lindane	Malathion	Methoxychlor
Metolachlor	Metribuzin	Parathion
Phorate	Prometryne	Simazine
2,4,5 Trichlorophenoxyacetic-Acid (2,4,5-T)		

Table 1 - B

Arsenic	Barium	Boron
Cadmium	Chromium	Cyanide
Lead	Mercury	Selenium
Uranium		

Table 1 - C

Benzene	Benzo(a)pyrene	Carbon Tetrachloride
1,2-Dichlorobenzene	1,4-Dichlorobenzene	1,2-Dichloroethane
Dichloromethane	Monochlorobenzene	Pentachlorophenol
Polychlorinated Biphenyls (PCBs)	Trichloroethylene	2,4,6-Trichlophenol

Table 2 - A

Alkalinity ($CaCO_3$)	Aluminum	Colour
Conductivity	Copper	Dissolved Organic Carbon
Hardness (as $CaCO_3$)	Iron	Manganese
Nitrate (N)	Nitrite (N)	Organic Nitrogen
pH	Sodium	Sulphate
Sulphide	Turbidity	

Table 1 - D

Aldicarb	Azinphos- methyl	Bendiocarb
Bromoxynil	2,4-Dichlorophenol	Diclofop-methyl

Individual requirements may be added for specific plants when required.

Dimethoate	Diquat	Diuron
Glyphosate	Nitrilotriacetic Acid	Paraquat
Picloram	Temephos	Terbufos
2,3,4,6-Tetrachlorophenol	Triallate	Trifluralin

Routine analytical methods for these parameters have yet to be developed, therefore monitoring for them will be conducted only in emergency situations.

MONITORING REVIEW

BIOMONITORING

NOVEMBER 1994

BIOMONITORING PROGRAM REVIEW

The following people are acknowledged for their work in the Biomonitoring Programs Review and this report;

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EXECUTIVE SUMMARY

A Ministry of Environment and Energy committee led by the Environmental Monitoring and Reporting Branch and comprised of representatives from the Operations Division and other branches of the Environmental Sciences and Standards Division, reviewed existing biomonitoring programs now carried out by the Ministry; to assess whether those programs are meeting their original goals and to recommend new directions for biomonitoring in Ontario.

The committee recommends that in addition to making a number of changes to existing programs, senior MOEE management endorse the expansion of biomonitoring efforts in areas that are described herein as "early warning" or "screening" programs, and in long-term (trend) monitoring. These changes are essential if the Ministry is to move from a reactive to proactive posture, and as it is challenged by new and emerging environmental issues. The changes will also position the Ministry to collect data essential to *State-of-the-Environment* reporting, while maintaining emphasis on high priority "adverse effects" monitoring.

The greatest hurdle will be to deliver these programs with reduced resources. The committee proposes that they be delivered in large part through the reduction of routine media-specific (air, water, soil) and biological monitoring of known point and area sources. Also, to achieve this goal, the Ministry will need to seek others who are willing to contribute resources; financial and/or in-kind assistance in support of the screening programs.

The committee also identified database development and coordination, biological standards and guidelines development, and laboratory analytical support (new contaminants, lower detection limits) as essential to biomonitoring in coming years.

1. BACKGROUND

Biomonitoring is the use of living organisms to assess environmental quality.

Between June 3 and October 13, 1994 a group of Ministry of Environment and Energy staff, representing the Operations Division and four Branches of the Environmental Sciences and Standards Division met to review the biomonitoring programs this Ministry conducts now, and make recommendations for the future. This program review was one of five initiated by the Environmental Monitoring and Reporting Branch. Other reviews were conducted of the Surface Water, Air Quality, Drinking Water and Ground Water Monitoring programs in the Ministry of Environment and Energy and are reported separately.

Direct monitoring of living organisms or "biota", in contrast to monitoring the air, water or soil in which they live, is carried out for several important reasons:

- monitoring of living organisms provides direct, irrefutable measures of *adverse effects*;
- living organisms integrate impacts from various sources and environmental stresses on their ecosystem; that is, their behaviour can reflect combinations of stresses simultaneously. They also integrate the impacts of temporal variations in emissions and discharges;
- biota respond to a variety of different chemical, physical and biological insults often at levels below existing analytical detection limits. As a result biological monitoring can reduce the time and cost involved in environmental impact assessment;
- a small change detected in one organism may alert us to greater change elsewhere in the food web;
- the public best understands environmental change as measured by effects on the plants and animals which they see around them; and,
- living organisms are the best indicators of the overall health of the natural environment and in affording this type of protection, we can provide even greater assurance of safety for humans.

These reasons remain valid in the 1990's and are reflected directly in legislative authority under the which environmental protection is provided (e.g., the Environmental Protection Act's adverse effects provisions) and in the MOEE mandate (... to protect and enhance the quality of the environment ...).

Direct monitoring of human health or monitoring of microbial problems was not addressed. These types of monitoring fall within the jurisdictions of other Ministries or local Medical Officers of Health. In addition, laboratory-based biomonitoring programs in support of standards development (bioassays) were not included in this review.

Biomonitoring programs in the Ministry of Environment and Energy have, over the past 25 to 30 years, taken advantage of strengths listed above to provide Ontarians with sound information upon which to assess their surroundings and make decisions on future environmental programs. In recent years biomonitoring requirements have been included in Certificates of Approval.

1.1 The Challenge

The opportunities to measure nature are virtually infinite. Recognizing that society's resources are not correspondingly infinite, there are attempts throughout the science to define so-called key indicators that might tell us a great deal more than just the health of that particular species. Some argue that monitoring top predators such as bald eagles, carnivorous mammals or sport fish is the right direction since these species integrate the impacts on organisms below them in the food web. Others argue we should focus on the base of the food web, the plants and invertebrates upon which higher animals depend for their existence. If the foundation of the food web is sound, the upper levels should be too. Still others suggest that we should look at ecosystem stability, answering such questions as: "are all niches in the food web occupied?", "how productive are the various trophic levels of the food web?", "is each species present in a given ecosystem represented by all expected age ranges or only by (say) very old specimens?".

In practice and for varying reasons it is advisable that we should do as much of each as we can afford, since each provides an important perspective.

1.2 Biomonitoring in Other Jurisdictions

To our knowledge, most jurisdictions biomonitor to some extent, the extent varying according to specific local needs and capabilities. The following provides a snapshot of nearby jurisdictions:

1.21 Terrestrial biomonitoring

No other Province or US State has an in-house group dedicated to the assessment of the quality of the terrestrial environment. Most jurisdictions have a few staff with biological backgrounds who are relied upon to provide guidance in the development of programs and standards with biological components. Monitoring activities are either required as a component of an industry's ongoing assessment of industrial emission compliance or they are contracted out to academic institutions with very considerable economic support. The role of government in most cases is to serve as auditors of performance.

In the case of larger, regional scale issues in the US, the investigation of terrestrial biological impacts is normally negotiated between the federal government and individual states, with the work performed by universities or privately operated research facilities. In some cases these facilities are co-sponsored by industrial associations who have significant input into the program design and implementation.

The National Science Foundation (NSF) in the US is funding a long-term biomonitoring study called the Long-Term Ecological Research (LTER) program. This study will estimate the biomass and productivity of primary and secondary producers within the food webs of lakes, streams, forests, grasslands, wetlands and alpine ecosystems throughout the US.

Ontario MNR has in the past issued health advisories for a very limited number of parameters representing specific collections of moose (cadmium in kidneys) and snapping turtles (PCBs in flesh), but there is no routine contaminant monitoring program in place.

1.22 Aquatic biomonitoring

Biomonitoring in aquatic ecosystems usually involves the observation or collection of one or more of the following group of species: algae (including the larger filamentous species that grow along shorelines and in rivers), zooplankton, bottom-dwelling (benthic) invertebrates, small (often called "forage") fish that provide food for larger predator fish and birds, game fish which might be consumed by the public, waterfowl or vascular plants (so-called macrophytes) that reside in rivers, streams and lakes.

At the national level in the United States, the Environmental Monitoring and Assessment Program (EMAP) is evaluating numerous potential biomonitors of aquatic and terrestrial ecosystem health. EMAP distinguishes between response indicators, exposure or habitat indicators, and stress indicators. For example, in aquatic ecosystems, EMAP staff are examining benthic invertebrates, algae, fish pathology, fish community structure, amphibians and reptiles as exposure indicators.

The biomonitoring programs of most US States include the use of benthic invertebrates to assess the water quality of streams, rivers, lakes, reservoirs and estuaries. The establishment of these programs was promoted by the 1988 US EPA requirement that States include "narrative biological criteria" in water quality standards. Each state has developed a program that reflects its specific geography and the agency's resources and mandates. The use of forage fish for contaminant biomonitoring as pioneered in Ontario, has been adopted by several Great Lakes States for specific

projects in localized areas.

Game or sport fish contaminant monitoring programs as a basis for human health advisories are among the most common biomonitoring initiatives found in other jurisdictions. All Great Lakes States have a sport fish consumption advisory program for their Great Lakes and inland waters. In New York, Michigan, Wisconsin and Minnesota these advisories are supported by a regular program of sport fish testing for contaminants such as PCB and mercury. Dioxin and some organic chemicals may also be measured in specific instances where a known contaminant source is under investigation. In Canada, Quebec has issued fish consumption advisories on a number of tested locations in the past. Most other Canadian provinces (except P.E.I and Newfoundland) have at some time or other monitored sport fish for one or more contaminants in one or more locations and issued an advisory.

Monitoring of waterfowl, both for contaminant levels and population health is done in Canada by the Canadian Wildlife Service (CWS). The CWS concentrate on species such as Herring Gulls, Cormorants, Eagles and Ospreys. New York State has tested and advised on the consumption of ducks and geese from the Hudson River area for PCBs, but this program is not routinely repeated. Most US work on fish-eating birds has been done by non-routine monitoring researchers.

2. BIOMONITORING PROGRAMS IN THE MINISTRY OF ENVIRONMENT & ENERGY: an assessment of existing programs

In this section the programs now conducted in the Ministry are assessed from the perspective of the environmental issues they address. This is done recognizing that most programs address more than one environmental stress.

In descriptive tables that are included in Appendix A, detail on each program is provided, including resources, clients served and collaborating partners. Assessments of each program's strengths, weaknesses and recommendations for improvements are also provided.

Most or all (as applicable) of the following criteria were applied in assessing each program:

- does the program meet specific needs, does it fulfil its original purpose;
- are there sufficient biological benchmarks/guidelines available;
- is the data adequately quality controlled;

- is the data properly managed;
- are we asking for more analyses than are necessary to fulfil program goals (are we getting too many non-detects back from the lab);
- can we reduce our dependency on costly chemical analyses; and,
- is the information being used (is there a client)?

Various lists of environmental issues have been created, usually for different purposes. For the purpose of this review, the list of issues (environmental stresses) driving biomonitoring programs is considered to be:

(a) emissions/discharges of toxic substances;
(b) nutrient enrichment (eutrophication);
(c) changes to the physical habitat of organisms, including:
  - particulate emissions/discharges (turbidity);
  - habitat destruction;
  - resource depletion (over-exploitation, poaching);
  - exotic species invasions;
  - temperature impacts (including global warming);
  - hydrological alterations (including ground and surface water depletion);
(d) acidification
(e) other regional or global influences, including:
  - ground level ozone;
  - UVB exposure due to stratospheric ozone depletion;
  - radionuclide deposition.

Two additional stresses were identified which include several of those listed above:

(f) urban environmental quality; and,
(g) rural environmental quality.

To avoid repetition within this section, these grouped stresses are not discussed separately. They are considered to be covered by those in the first list.

2.1 Review of Current MOEE Biomonitoring Programs

2.11 Emissions/discharges of toxic substances

Reflecting the direct, health-related concerns of Ontarians during the past 25 years, more than half the biomonitoring programs conducted by the Ministry focus wholly or at least in part on monitoring contaminants in living organisms, in particular bioaccumulation of persistent toxic contaminants. (The program numbers provide reference to the tables in Appendix A):

1. Sport Fish Contaminant Monitoring Program
2. Forage Fish Contaminant Monitoring Program
4. Regional support (Biomonitoring Section)
6. Fish health monitoring (including Mixed Function Oxidase bioassay)
7. Terrestrial Standards Development (Ontario Typical Ranges)
8. Terrestrial Effects Assessment - Point Sources
9. Terrestrial Effects Assessment - Public Complaints
10. Terrestrial Effects Assessment - Non-point Sources
11. Great Lakes Screening Level Investigations
12. Great Lakes Remedial Action Plan support
13. Long-term (Great Lakes) Sensing Sites
17. Caged Fish Studies

In the above programs contamination is monitored in sport and forage fish, aquatic invertebrates, terrestrial vegetation and to a much lesser extent, algae. The contaminants monitored include a wide range of metals and organic compounds, appropriate to the known and suspected sources. In both terrestrial and aquatic ecosystem studies, occasional broad scans may be done for non-routine compounds. Eight of the programs (2, 4, 6, 8, 9, 11, 12 and 17) focus on identifiable point sources, the remainder on non-point sources, although it is occasionally difficult to categorize programs in this way since some programs may do both. Seven of the programs (1, 2, 8, 10, 11, 12, 13) provide measures of contaminant trends over at least five years.

For the most part the coverage provided by these programs is judged to be good. The program assessment tables list, however, a variety of recommended refinements. The following themes emerge:

(a) there is a need to focus efforts more on the detection of adverse effects, as opposed to contaminant concentrations and on long term and early warning/screening surveys, particularly in support of state-of-the-environment reporting;
(b) there is a need to reduce routine surveys/sampling where staff already "know what they will find"; particularly sampling that results routinely in large numbers of "non-detects";
(c) results from all monitoring surveys must be provided in a more timely manner, even at the expense of reducing the number of surveys and samples taken;
(d) improved data storage and accessibility is essential;
(e) there is a need to develop laboratory methods for measuring chemicals not now analysed (e.g., co-planar PCBs, polychlorinated diphenyl ethers, polychlorinated naphthalenes) and for lower detection limits for currently analysed contaminants; and for more rapid portable analysers which can

provide on-site analysis of samples, minimizing the need to collect, process and submit samples to centralized laboratories;

(f) improved coordination of field efforts and report preparation for specific point sources is advisable;

(g) some resource savings are possible through improved efficiencies achieved above; and,

(h) there is a need to examine the resourcing of biomonitoring programs in relation to media specific monitoring with a view to achieving a better balance in how MOEE spends its money.

2.12 Nutrient enrichment

Monitoring of nutrient enrichment applies largely, if not entirely to aquatic ecosystems; waterbodies which receive excessive phosphorus discharges. These discharges have over time resulted in high algal growth rates and often radical changes to the food web, including destruction of fisheries. Based on the number of programs designed wholly or in part to address it, monitoring eutrophication constitutes the second most common type of biomonitoring program in the Ministry. Many of the following programs monitor algal and/or macrophyte abundance, as a part of their mandate. Again the numbers that precede each program title, serve as references to the Appendix A tables.

3. Great Lakes (water treatment plant) Intakes Program
4. Special Studies (various ESSD divisions)
5. Inland Lakes Restoration
11. Great Lakes Screening Level Investigations
12. Great Lakes Remedial Action Plan support
13. Long-term (Great Lakes) Sensing Sites
14. Muskoka Lakes Study (Plankton and Benthos sub-programs)
15. Lake Simcoe Environmental Management Strategy
18. BioMAP

Due mainly to discharges from sewage treatment plants, private waste (septic) systems and run-off from farmland, eutrophication problems continue to affect Ontario ecosystems. Ironically, the problems are declining in severity in the Great Lakes, as much for reasons associated with another environmental stress, as to reductions in phosphorus discharges. The zebra mussel invasion of the lower Great Lakes, connecting waterways and now a number of the inland rivers, streams and lakes, has the potential to reduce algal populations to very low levels, based on experience in Lake Erie, and may threaten those ecosystems due to diversion of energy from zooplankton and fish.

Like toxic discharges and emissions monitoring, nutrient enrichment is relatively well monitored in Ontario. Refinements will continue to be needed however, to maintain viable programs:

(a) the cost of outside contracted algal assays (biomass and taxonomy) may become unsustainable if budget cuts continue;
(b) improved data storage and accessibility is needed;
(c) improved sample/specimen storage and curatorial services are needed;
(d) some resource savings may be possible through improved efficiencies.

2.13 Changes to the physical habitats of organisms, including:

- particulate discharges (causing turbidity)/emissions;
- habitat destruction;
- over-exploitation, (including poaching);
- exotic species invasions;
- temperature impacts (including global warming);
- hydrological alterations (including groundwater depletion).

The persistent or repeated impact of a variety of these stresses, alone or in combination can lead to the exclusion of species from an ecosystem and in extreme cases lead to the complete restructuring of an ecosystem and associated reduced biodiversity. The following programs monitor one or more of these stresses and in a number of cases monitor biodiversity directly:

3. Great Lakes (water plant) Intakes Program
6. Fish Health Monitoring (including MFO's)
11. Great Lakes Screening Level Investigations
12. Great Lakes Remedial Action Plan support
13. Long-term (Great Lakes) Sensing Sites
14. Muskoka Lakes Study (Plankton and Benthos sub-programs)
15. Lake Simcoe Environmental Management Study
16. Long-range Transport - Biological
18. BioMAP

Complementing these programs are programs both in other levels of government, in particular the Canadian Wildlife Service of Environment Canada, the federal Department of Fisheries and Oceans and numerous volunteer organizations. A list of biomonitoring-related databases that exist for Ontario biota is attached as Appendix B. A coordinated effort to make this data available to those who report on the state of the environment is needed.

The general themes arising from the examination of these and other potential programs that measure success of organisms, are:

(a) although there appears to be a large number of programs addressing aquatic habitat issues, many of these programs are restricted geographically in scope, although some involve collaboration with other provincial and federal agencies;
(b) the assessment of equivalent impacts on terrestrial ecosystems has received little or no attention;
(c) due to (a) and (b), there is a pressing need to increase activity in the area of monitoring plant and animal communities, if the MOEE is to deliver on the objective of measuring ecosystem health and closely associated issues of preservation of biodiversity and habitat destruction;
(d) greatly improved data storage and accessibility is imperative; and,
(e) the cost of identification of biological samples may be high if contracted out, with the result that unless alternatives are developed, increasing these assays could consume more resources than desirable or sustainable.

2.14 Acidification

Ontario continues to lead the world in understanding the effects of acid precipitation. As part of the Acid Precipitation In Ontario Study (APIOS) and Countdown Acid Rain, a number of programs provide data to assess the continuing impacts and subsequent recovery of inland ecosystems from acidification. Recent findings suggest that recovery is aggravated by drought conditions associated with climate warming. The integrated ecosystem-wide effects of combined environmental stresses including acidification, Long-Range Transport of Airborne Pollutants (LRTAP) and climatic changes needs further work. Moreover, the characterization of unimpacted or background conditions has been identified as a major requirement to provide recovery targets and to assess the effectiveness of various remedial and regulatory actions.

The following programs provide data to assess the impacts and potential recovery from acidification-related issues:

7. Terrestrial Standards Development (Ontario Typical Ranges)
8. Terrestrial Effects Assessment - Point Sources
10. Terrestrial Effects Assessment - Non-point Sources
14. Muskoka Lakes Study (Plankton and Benthos sub-programs)
16. Long-Range Transport of Air Pollution - Biological (includes Stream Benthos, Littoral Benthos and Lake Plankton sub-programs)

Most of these programs involve collaboration with other provincial and federal agencies with various data-sharing arrangements. Because of the long time frame for these studies, several programs have generated time-series data spanning between five and 20 years. These types of long-term data sets are extremely rare and could with some minor adjustments, be used to monitor the cumulative impacts of environmental stresses such as habitat alterations, UVB exposure and climate change.

Most of these programs have suffered from annual incremental reductions in resource allocation such that:

(a) lower priority samples are pooled or archived, thereby creating gaps in the time series and limiting the value of these unique long-term databases on ecosystem health;
(b) professional staff are often forced to undertake technical tasks due to staff reductions, thereby lengthening the period for program delivery;
(c) these programs now focus on long-term, rather than early-warning indicators because of (a) and (b) above;
(d) there is a need for improved quality assurance and quality control (QA/QC) and database management given the long-term nature of the data sets; and,
(e) the costs associated with the identification of biological samples are a large proportion of the ODOE that is spent on external contracts.

2.15 Other regional or global issues including ground-level ozone, stratospheric ozone depletion; and, radionuclides

Although ground-level ozone is believed to be costing Ontario growers as much as $70 million annually in lost productivity and to be resulting in significant human health costs (lung diseases and dysfunction), Ontario has only one monitoring program that in part addresses ground-level ozone effects. Likewise there are now only weakly resourced attempts to monitor the impacts of stratospheric ozone depletion (increasing UVB) on ecosystems or deposition of radionuclides. The *Terrestrial Effects Assessment, Non-point Source* program has suffered recently, as staff have been moved to other standards-related, higher priority assignments.

Long-term monitoring efforts with appropriate resources will be needed in each of these fields if the Ministry wants the monitoring data needed to measure success or rate of improvement due to new Ministry programs. This is particularly true for ground-level ozone impact, where air quality ambient measurements can provide only a rough indication of impact since ozone damage depends on other environmental conditions such a soil

moisture, humidity, wind speed, etc. Of even greater importance is the need for assessment of ozone and other LRTAP pollutant impacts on forest health, a key component of Ontario's economic base.

Radioactivity has been monitored in southern Ontario, normally to provide background data for the nuclear contingency plans for each of the major electrical power generating developments. A province-wide vegetation sampling program is now in place as part of a multi-Ministry *Provincial Nuclear Monitoring Plan*. Fish from near the Pickering, Darlington and Bruce Nuclear Power Developments have been sampled periodically and submitted for radioactivity analyses.

2.2 General Assessment of Existing Program Coverage

When combined in tabular form (Table 1) the program review provides a revealing picture of Ministry biomonitoring activities.

The Ministry has good programs for monitoring inorganic and organic contaminants in several groups of organisms within the food web. This contamination is the consequence of emissions and discharges from both identifiable point sources and dispersed area or non-point sources. Work at the Canadian Wildlife Service (CWS) of Environment Canada complements this work through their monitoring of contaminants in waterfowl, shorebirds and a few selected terrestrial vertebrates. Whether provincially or federally coordinated, Ontario lacks a routine program to monitor contaminants in vertebrates other than birds and fish. A collaborative program with the Ministry of Natural Resources, fashioned after the Sport Fish Contaminant Monitoring Program should be considered to monitor contaminants in non-fish vertebrates.

The MOEE is also able to describe the degree to which many waterbodies in Ontario have become adversely impacted by excessive algal growth, the product of nutrient enrichment. Finally the MOEE is an acknowledged world leader in monitoring the impacts of acid precipitation on aquatic ecosystems. These long-term assessments should continue.

Operations Division members of the committee expressed concern that turnaround time for biomonitoring results is still too slow, that if the information is to be useful it must be published faster. The countering argument, that in a number of cases the results are part of long-term assessments and meaningful results cannot be expected in timeframes of less than a year, should also be considered. To improve turnaround time it will be necessary to conduct more assays in the field, to reduce our reliance on

external expertise and to examine alternate methods of reporting results.

The Ministry has a few good programs to assess physical habitats in aquatic ecosystems, but they are limited geographically: the Southwestern Region, selected areas on the Great lakes and their connecting channels, certain lakes within range of the Dorset laboratory and a number of southern Ontario streams and rivers. The Ministry does not however, have an integrated approach to monitoring efforts that can speak to the health of Ontario's aquatic ecosystems in general and the success of many organisms in occupying their niches within those ecosystems. This type of integration would provide the basis for improved *State of the Environment* reporting. An integrated approach is warranted, as is expanded use of relational databases to make the data more accessible.

Other organizations, within the Ontario Government (MNR), in the federal government and in volunteer groups, provide good coverage in a number of biomonitoring areas which speak to the general issue of environmental health. For instance, programs exist to monitor amphibians (MNR, volunteer organizations and the Metro Toronto Zoo), land and forest birds (volunteer organizations and the CWS), birds of prey (CWS). These programs focus on population studies to determine whether the target species continue to thrive; whether they are threatened.

The Ministry is generally lacking in the ability to determine the impacts of various stresses such as ground-level ozone, global warming or stratospheric ozone layer depletion. Each one in this group of environmental stresses threatens ecosystem health in ways that are not detected easily without sound, long-term monitoring designed specifically to assess these impacts. Databases exist at Dorset to begin useful work on the global warming issue.

The Ministry's data management systems are not meeting current needs. As resources shrink, the need to improve accessibility of existing data increases. The MOEE however, does not face this problem alone. Much of the environmental monitoring data held by other levels of government and volunteer organizations is difficult to access (please see Appendix B).

3. IMPROVING BIOMONITORING IN ONTARIO BEYOND EXISTING PROGRAMS

In the preceding section the various programs now underway in the Ministry were described, and some suggestions on how these programs could be improved were proposed; both general suggestions in the text and program-specific recommendations in the tables of Appendix A. Improving existing programs however, will not alone address the gaps identified above, nor will it adequately

address emerging issues.

To assess gaps and needs of the Ministry's biomonitoring programs it is necessary to step back and look at the general reasons jurisdictions monitor living organisms. The graphic below summarizes these reasons. All ecosystem concerns start with some structured or informal form of biomonitoring: contaminants are suspected in living organisms; various species are no longer observed in their normal habitat or perhaps the population of a particular species is observed to include few younger specimens. Where concerns are raised (and resources are available) these first observations are followed by more focused programs that determine the cause and define the extent of the problem. Once defined and action taken, a problem may then be tracked over time to determine whether the impact of the stressor is being reduced through remedial efforts or pollutant control measures. This view is comparable to the three stage Remedial Action Plan approach.

Most Ministry biomonitoring programs are of a narrow or focused type. In this section, a broad recommendation is made that would see a somewhat reduced effort in focused programs, with the redirected resources going to more work on early warning programs and long term monitoring. The underlying rationale for this direction is resources. Neither this Ministry, nor the MOEE in concert with other jurisdictions can afford to intensely monitor everything that warrants attention. Good, front-end screening programs must be used to better focus the Ministry's regular monitoring programs.

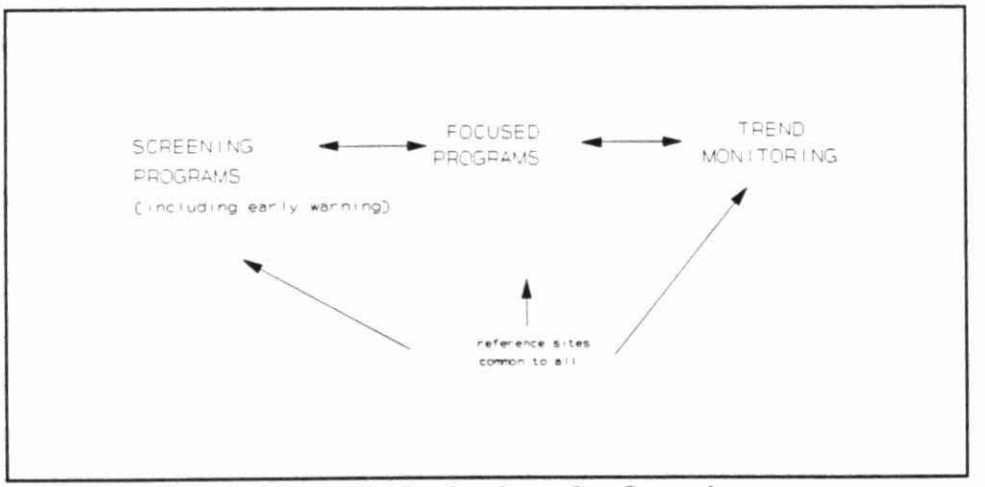

Figure 1: Environmental Monitoring: An Overview

Table 1: Overview of Program Coverage in Ontario, All Jurisdictions

Environmental Stress	Overview of Existing Monitoring for Eight Major Biological Groups							
	Terrestrial vegetation	Aquatic vegetation	Phyto-plankton	Zoo-plankton	Benthic Invert's	Amphibians & Reptiles	Aquatic vertebrates	Terrestrial vertebrates
Global warming								
Ground-level ozone	np	n/a	n/a	n/a	n/a	n/a	n/a	n/a
UVB (stratospheric ozone depletion)								
Toxic releases	PS		ps/np	ps/NP	PS/NP		PS/NP	
Acidification	np*		NP	NP	NP			
Eutrophication	n/a		PS/NP	np	PS/NP		NP	n/a
Habitat/ wetland destruction	n/a		n/a	ps	PS			
Physical substances			np	ps/np	PS/NP		PS	
Exotic species invasions			NP	NP	NP			
Radionuclides	np							
Urbanization			np		NP		NP	
Agricultural impacts			np		NP		NP	
Water flow alterations					PS		PS	

Key:
- PS/ps — indicates only that the MOEE has at least some program coverage for this stressor, focused on point source(s) (caps indicate strong position)
- NP/np — indicates only that the MOEE has at least some program coverage for this stressor, focused on non-point source(s) (caps indicate strong position)
- n/a — indicates not applicable
- shading — indicates significant coverage by another jurisdiction or volunteer organizations
- * — the major effort here in the 1980's has been substantially reduced due to demands in higher priority areas

3.1 Cost-effective, Screening (Early-warning) Programs

The committee identified the need for a "tool-kit" of cost effective, early warning programs that serve as screening tools to identify problems before environmental damage becomes critical or irreversible and that permit the Ministry to better focus its regular, ongoing monitoring (biomonitoring and media-specific) programs. It was recognized that there was no one universal "tool" that would serve all needs.

Monitoring benthic invertebrate populations provides one well-established avenue for screening waterbodies for environmental impacts. Although they respond, for the most part non-specifically to various stresses, they offer important early views of impending trouble. There are for **aquatic ecosystems**, a number of program models that use stream and river bottom fauna - benthic macroinvertebrate assemblages. Because of the wide range of sensitivities of these species, routine benthic surveys can detect emerging problems before traditional water-quality (i.e., chemical) analyses. Relative numbers of particular species and presence/absence of others form the basis for evaluation. This type of early warning survey would trigger other, more costly but focused assessments if anomalous conditions were observed. Depending on the nature of the environmental stress, different monitoring programs can then be focused on the abnormal sites to confirm the existence of the problem and its severity.

There have been a number of studies carried out in Ontario using benthic macroinvertebrate community assessments as measures of aquatic ecosystem health. Such studies have formed the basis of sediment quality studies in the St. Marys River, Lake St. Clair, the St. Clair River, the Detroit River, the Niagara River, Lake Ontario and the St. Lawrence River; several of the studies have been done periodically since 1968 and therefore are also useful in long term trend assessment. The staff of the Southwestern Region of the Operations Division have proposed a program that uses benthic macroinvertebrates. They have already implemented their *BioMAP* which is comparable to programs that exist to varying degrees in several neighbouring jurisdictions. A similar stream invertebrate protocol is used in the Long Range Transport of Air Pollution (LRTAP) Stream benthos biomonitoring program. A lake analogue of the BioMAP approach can be found in the LRTAP Littoral Benthos studies, the LRTAP Plankton and the Muskoka Lakes Benthos and Plankton programs in the inland lakes. We suggest that using the examples above, the Ministry implement an aquatic ecosystem sampling program (network) in southern Ontario that builds on the strengths, and uses as potential models the various benthic invertebrate and other aquatic ecosystem screening programs such as forage fish sampling and liver enzyme induction programs already in place. In northern Ontario where the environmental issues are more focused in nature, such screening programs have less immediate value.

The cost of developing a southern Ontario benthic invertebrate monitoring network,

regardless of the model used, will, to keep costs in line, require assistance from outside groups. The Ministry must seek partnerships, in particular with volunteer groups and conservation authorities.

For aquatic systems, however, benthic invertebrate work alone will not suffice, particularly where persistent contaminant problems are suspected. Forage fish collections and other subtle biomonitors such as caged mussels would continue to complement benthic studies, providing a relatively quick method of assessing waterbodies for contaminants.

As have other jurisdictions (e.g., Germany, Sweden), the MOEE has investigated the use of enzyme activity in fish as an indicator of exposure to a range of substances in their environment. Laboratory development work in this area is being transferred to field use in Ontario. Its use as a measure of exposure to non-persistent toxic contaminants which are not usually accumulated fish at quantifiable levels, is being investigated.

An emerging screening tool that offers promising returns is *immunoassay screening*. Used either in the field or in the laboratory, immunoassay kits could be useful in polyaromatic hydrocarbon (PAH) assays at levels down to 0.5 ppm, well below, for example, the lowest effect level for total PAHs in sediment.

To complement aquatic programs the Ministry needs to develop **terrestrial ecosystem screening programs**. The US EPA EMAP program is described briefly above (p.4). Under EMAP, terrestrial observation plots will be established in all major ecotypes. The purpose is to monitor population dynamics in representative ecotypes with the intent of relating any changes or alterations in local ecosystems as a result of environmental degradation or climate change. The MOEE Hardwood Forest Health Survey Plots (part of the Terrestrial Effects Assessment program - Non-point Sources) are a good example of a forest ecotype plot that could be used as a starting point for a similar program. Alternately or in addition to these sites, the Ministry could associate itself with the federal initiative to develop *Ecological Science Centres* in each of Canada's 15 ecozones, three of which are in Ontario. Ontario is well positioned to contribute to two of these programs: the Mixed Wood Plains ecosystem and the Boreal Shield ecosystem. Programs such as these can be expected to identify the impact of stresses such as ozone on forest trees or subtle changes in plant communities due to climate change.

An alternative to coordinating terrestrial ecosystem screening with the federal initiative (which could be seriously reduced by budget reductions), would be to add a terrestrial component to the above proposed MOEE aquatic screening program.

Because terrestrial programs can be significantly more labour intensive it is essential that the Ministry seek out others to share the cost burden and contribute expertise.

Last but not least, one of the most cost-effective forms of early warning lies in the expertise of staff. That expertise must be maintained through exchanges with scientists and regulators in other jurisdictions. This is most effectively achieved through regular conference attendance, although electronic tools such as *Internet* may prove to be just as useful.

3.2 Long-term Biomonitoring Programs

Long-term monitoring programs are consistently the most difficult to defend in the face of budget cuts; yet, among the most important to maintain. Not only do they provide long-term trend information (are we winning or losing?), they provide the measures of normal (reference data) against which the abnormal is judged. It is impossible to convince a Court that something is wrong if "right" is not defined.

The need for long-term sensing programs/sites is consequently intrinsically linked to screening programs. For example, the BioMAP program includes 10 long-term reference sites. Currently, 48 reference sites form the basis of the Long-Term Sensing Sites Program for the Great Lakes and Interconnecting Channels and integrated macroinvertebrate community and sediment quality assessments are periodically conducted in Interconnecting Channels and the nearshore of the Great Lakes as part of the Remedial Action Plans Program. Reference sites have also been incorporated into the LRTAP Littoral Benthos, Stream Benthos and Plankton biomonitoring programs and the Muskoka Lakes Plankton, Nearshore Benthos programs and Fish Health Biomonitoring. All reference site networks/programs should be reviewed for their general utility and regional representativeness.

3.3 Database development

There is a pressing need to have MOEE data more readily available to scientists both within and outside the Ministry. Of the 21 Ministry programs referenced in this report as having biological components, the data from only seven are stored in sophisticated databases (4 on Oracle, 3 in dBase III/IV) and of those, only the three Oracle databases are "relational" - databases which can be queried using a common language since their data fields are consistently named.

Although arguably the most important area in which program changes should take place, improved database management will be costly. In some cases MOEE biological data exist only as paper files and questionable files stored on the old SIS system at Downsview. If the development of the sport fish contaminant database (*Fishbase*) is a measure of future resource needs, costs (ODOE and human) associated with updating MOEE data will range between $250 and $500K per major database, depending on the amount of data and the degree to which the data

require verification.

The Ministry should however, proceed with data conversion and database development. One example of this type of initiative is the Phytotoxicology Information Management System which is now proceeding to Ministry approval. As all public organizations move to reduce expenditures there is increasing pressure to share data. Organizations that lack the ability to make their data available to other organisations will encounter reduced access to other's data.

3.4 Biological Standards and Guidelines

The Biomonitoring Program Review identified a common problem associated with all biological assessments: the need for biological criteria and guidelines. While in many cases chemical characterization of point sources agree with direct measures of biological effects, there are also cases where the biological effects measures contradict what would be predicted by chemical or physical analyses. Similarly, chemical-based standards based on literature reviews of potential biological effects can result in different predictions than actual measures of biological effects in the receiving environment or in samples taken from the receiving environment and tested for biological effects in the laboratory. Standards or guidelines against which to compare direct measures of biological effects could overcome these ambiguities and could give us benchmarks for substances for which we have yet to develop media-specific standards. These standards or guidelines would be for biological effects such as lethality, growth, reproduction, enzyme activity and community structure.

3.5 Contracting-out Biological Sample Assays/Analyses

The costs of contracted out analyses of biota (mainly phytoplankton, zooplankton and benthic invertebrates) represent a significant portion of ODOE spending on biomonitoring. These costs must be controlled.

There are essentially three options, each assuming that scientists continue to request only those minimum number of analyses and that the MOEE continue to share these costs wherever possible:

(a) contract most analyses to large consulting companies; or,

(b) internalize the analyses by utilizing existing staff with appropriate expertise thereby relieving those individuals of their current assignments and using outside contractors for essential peak loads;

(c) contract most analyses to smaller consulting companies who are effectively cottage industries (e.g., the work done mainly in private homes).

When the costs are broken down, even including buried costs such as overhead for government buildings and the costs associated with QA/QC of outside laboratories, the costs associated with contracting to large consulting companies (option a) are prohibitive, as much as twice the cost of doing the work in-house in the case of phytoplankton assays. As an alternative, (option b) however, many of Ministry staff who used to perform these tasks have either left the public service or have assumed other duties. Consequently fully internalizing the analyses is no longer an option without significant changes in duties and probable creation of new positions.

We are therefore left with the third option (use of cottage industry consultants), our current strategy, but one which is tenuous - smaller contractors come and go. To reduce the uncertainty of this option, the Ministry should promote the development of this technical expertise through in-house training in areas of biological analyses such as phytoplankton, zooplankton and benthic invertebrate assays.

3.6 Research in support of Biomonitoring

Biomonitoring will continue to need research support. Since research needs are dealt with in another forum (the Environmental Research Program), only an abbreviated list of biomonitoring research topics is provided here:

(a) identification of new biomonitoring methods including indicators of ecosystem health and stress-specific sensitive receptors;
(b) subtle pollution effects such as may be indicated by biochemical changes in tree xylem or vertebrate enzyme systems;
(c) the effects of ground-level ozone on forests;
(d) identifying and monitoring recovery of terrestrial and aquatic ecosystems;
(e) use of aquatic macrophytes as monitors of contaminated sites;
(f) field survey design-related research focusing on such variables as sampling frequency and intensity;
(g) assessment of interactions between environmental stress (i.e., do the effects of one stress mask or enhance others?).

4. OPTIONS FOR MOEE BIOMONITORING ACTIVITIES IN THE NEAR AND LONG-TERM

In this section two options are presented which can be characterized as a choice between (a) business as usual with staff modifying existing biomonitoring programs to generate modest reductions in resource needs; and (b) a re-direction of a

significant portion of the current biomonitoring-related resources, away from routine assessments, towards screening surveys to provide better early warning information and more long-term monitoring in support of *State-of-the-Environment* reporting. The guiding philosophy in reducing or eliminating surveys would be that with the exception of long-term reference sites, no survey would be conducted where the results are largely predictable.

OPTION 1

Subject to approval of the impacted ESSD Branches, implement the changes recommended for each **existing** program. A number of specific examples from the tables in Appendix A are listed here as examples (as shown in the order in which they appear in the tables):

(a) implement changes to the display of fish consumption advisories in the next *Guide to Eating Ontario Sport Fish*;
(b) archive phytoplankton samples collected under the Great Lakes Intakes Program and seek outside financial support for their analyses for a saving of approximately $21K per annum but with the potential loss of the long-term trend data;
(c) develop new laboratory analysis methodologies to meet emerging needs; e.g., co-planar PCB analyses, lower analytical detection limits for various organic compounds in vegetation and soils;
(d) reduce the number of vegetation and soils investigations where there are no scientific grounds for the (public) request; where the request is made largely to resolve specific disputes between neighbours; in support of real estate transactions;
(f) capture historical (e.g., complaint-related) data into Phytotoxicology Information Management System (PIMS) for SOER and other public information needs;
(g) better prioritize monitoring under RAPs;
(h) re-evaluate all monitoring survey results to reduce the number of non-detects, with potentially reduced laboratory loads;
(i) continue to seek out new biomonitors that offer potentially lower costs; and,
(j) to ensure efficient, cost-effective biomonitoring efforts, conduct a program-by-program efficiency assessment review to determine optimal sampling designs, with appropriate sampling frequency and effort, and to ensure sufficient statistical power to detect ecologically important changes and long-term trends in reliable biological indicators.

Resource savings would be invested largely in database management to make what data the MOEE has more readily available to others and where applicable (applies only to certain ESSD sections) to improving turnaround time on high priority Operations Division requests.

OPTION 2

In addition to the recommended changes in *Option 1*, coordinate and where necessary expand biomonitoring programs across southern Ontario to provide the early warning (screening) capability essential for sound environmental management in Ontario and the long-term monitoring data needed for *state-of-the-environment* monitoring, for both terrestrial and aquatic ecosystems by:

(a) developing a collaborative southern Ontario inland waters sampling network that builds on the strengths and uses as potential models the existing biomonitoring programs such as BioMAP and other benthic macroinvertebrate monitoring programs, forage fish sampling and liver enzyme induction programs already in place. This network would complement similar work already underway in the Great Lakes and Interconnecting Channels. Such a network would be developed with the possibility that it be implemented at the field level by either volunteers or by conservation authority staff, with coordination and scientific guidance by MOEE staff. As first steps toward the development of such a program, MOEE staff (possibly those who met as the Biomonitoring Program Review) would:

- meet with staff of other Ministries and other levels of government who have a stake in such a program to seek their cooperation and buy-in with respect to resources or at least in-kind cooperation;
- establish a committed nucleus of MOEE staff with essential biomonitoring knowledge who would guide implementation of such a network in an MOEE region other than the Southwestern Region (based on the assumption that BioMAP will continue in the London region in 1995);

(b) committing support to the Environment Canada-led *Ecological Science Centres* initiative with efforts to share resources, expertise and data. Alternatively a terrestrial component could be developed to complement the southern Ontario inland waters sampling program proposed above; and,

(c) developing new biological standards and guidelines.

This option is envisaged to be resource-neutral through the cooperation of outside parties and through a reduction in, and optimization of, the biomonitoring programs now conducted by ESSD staff. However, if additional resources are needed to achieve the programs goals, these should be sought through re-deployment of resources from lower priority activities in the Ministry.

RECOMMENDATION: The Biomonitoring Review Committee recommends acceptance of Option 2.

APPENDIX A

The attached tables describe in detail, each monitoring program in the Ministry which has a significant biomonitoring component. Some programs where there is a biomonitoring component, but it is relatively minor in scope, e.g., the several cottager self-help programs, are not included. Other programs such as the *Ecosystem Approach to Water Resource Management* which is conducted jointly between the Science and Technology Branch and the Environmental Monitoring and Reporting Branch, is considered to fall under program 4, specialized studies.

When itemizing resources applied to each program, committee members attempted to separate the purely biological components from the chemistry and sediment work. The branches or divisions which bear the costs are shown in brackets. In some cases where they can be estimated with some precision, resource savings associated with recommended program-specific changes, are shown.

1. Sport Fish Contaminant Monitoring Program - Biomonitoring Section, EMRB, ESSD

Program Purpose Environmental Stressors Monitored	Year program started	In collaboration with ... (indicate lead and nature or co-operation)	MOEE Person years	MOEE ODOE	Status of comparable programs in other jurisdictions	Number of sites and sites per year sampled	Frequency of reporting	Clients
To protect the health of consumers of fish caught (sport and recreational activity) in Ontario waterbodies, advice is provided to the public on recommended consumption limits (weekly, monthly). Analyses are done for inorganic substances (mainly mercury, but occasionally other metals), PCBs, mirex, various pesticides, dioxins and furans. The results are published every other year in the *Guide to Eating Ontario Sport Fish* and provided to Environment Canada under the Canada/Ontario Agreement, primarily for reporting under the *Canada/US Great Lakes Water Quality Agreement*. This program monitors one of the effects of **deposition/discharges of toxic substances** to Ontario waterbodies.	1976	MNR Health Canada First Nations angling associations	2.5 (EMRB) 7 (LSB)	$45K (EMRB) $57K (LSB)	fish consumption advisories are provided in other Canadian provinces and US states, none are as extensive due to number of lakes and importance of recreational fisheries to the local economies	approx. 200 lakes samples or re-sampled	every other year in the *Guide to Eating Ontario Sport Fish*	3 million anglers who purchase fishing licences annually in Ontario

Strengths	Weaknesses	Recommended changes	Resource Implications
• timely advice to recreational (sport) anglers on what fish they should or should not consume from over 1600 Ontario waterbodies including the Great Lakes • a high profile Ontario Government program that is regularly subjected to public scrutiny and comment (report on public responses to questionnaire available) • program covers approximately 98% of the lakes considered popular by Ontario anglers • strong inter-agency, cooperative component to program: MNR (fish catches, database development), Health Canada (human health issues), First Nations (fish catches), others (fish catches)	• publication of *Guide* every other year is not "timely", necessitating interim, controversial advisories • lack of permanent field staff to the program inhibits collection of fish from many lakes • program is paper-intensive, in need of computerization. *Fishbase* is not yet available beyond EMRB and certain MNR staff, inhibiting data accessibility by users inside and outside the MOEE	• continued commitment to getting *Fishbase* on-line; data verification paramount • increase field staff commitment to improve collection quality • implement new advisory display methods and new advisories, in next issue of the *Guide* • explore revenue generation through advertising in the *Guide* • make interim revisions/updates to the *Guide* and possibly the *Guide* itself, accessible on-line (e.g., like EBR, at public libraries)	• advertising (in the *Guide*) revenue might offset publication costs (goal of $90K reduction, <u>if deemed feasible by PACS</u>) • if in the course of the CCME harmonization activities, the DFO withdraws from sampling of fresh water fish for contaminants, the SFCMP could be expected to pick up the slack. This would have significant resource implications

2. Forage Fish Contaminant Monitoring Program - Biomonitoring Section, EMRB, ESSD

Program Purpose Environmental Stressors Monitored	Year program started	In collaboration with ... (indicate lead and nature or co-operation)	MOEE Person years	MOEE ODOE	Status of comparable programs in other jurisdictions	Number of sites and sites per year sampled	Frequency of reporting	Clients
Forage* fish (small fish, including what are often called "minnows") are used to monitor persistent contaminants in lakes, rivers and streams. These fish provide food for larger (predator) fish and fish-eating waterfowl. Knowledge of contaminant levels in these fish provides information on the potential for those contaminants to bioaccumulate in the food web. These fish are also used to assess temporal and spacial trends of these contaminants. So-called young-of-the-year* (YOY) fish are particularly useful because in their first year of life, they do not move far from the area where they hatch and the data can consequently be used to monitor discharges from point sources. This program monitors the effects of **emissions/discharges of toxic substances** to Ontario waterbodies.	1975	Operations Division (e.g., part of Niagara River Toxics Management Plan, and monitoring northern Ontario point sources)	1 (EMRB) 1 (LSB)	$15K (EMRB) $9K (LSB)	New York State Department of Environmental Conservation (as reported August, 1994 in *Identification of changes and chemical contaminant levels in YOY fish...)*	15-20	technical memoranda, annual reports, occasional scientific journal publications, MOEE "greenbacks"	MOEE Operations Division, IJC, RAPs, Niagara River Toxics Cmte

* the term *forage fish* is applied generally to all fish species that provide food for predator fish and wildlife. *Young-of-the-year* fish are that part of the forage fish population which hatched in the current season.

Strengths	Weaknesses	Recommended changes	Resource Implications
• program provides a relatively low-cost method for assessing point and non-point source contamination • relative ease of sample collection • results reflect time-integrated changes in water quality • undifferentiated food habits of young fish and the use of 10 fish composite samples lead to low variability of contaminant residues within a given population • example of a good contaminant oriented "screening program"	• selection of a given species is linked to specific habitat characteristics (there are no guarantees that the same species can be found (for comparative purposes) throughout a watershed • sampling season is short for YOY fish	• greater use of forage fish collections to assess contamination in waterbodies where sport fish numbers are low • increase availability of data to public (perhaps through more summary reports)	• one EMRB staff member is retiring in spring, 1995. Replacement is essential to maintaining program at current level • no change in ODOE resourcing recommended

3. Great lakes Intakes Monitoring Program - Biomonitoring Section, EMRB, ESSD

Program Purpose Environmental Stressors Monitored	Year program started	In collaboration with ... (indicate lead and nature or co-operation)	MOEE Person years	MOEE ODOE	Status of comparable programs in other jurisdictions	Number of sites and sites per year sampled	Frequency of reporting	Clients
To monitor the impacts of nutrient enrichment (eutrophication or conversely, reduced eutrophication) in the Great Lakes, eighteen water intakes are monitored weekly for nutrients, and chlorophyll. 13 of these intakes are monitored for phytoplankton, with sampling done locally by plant operators. Algal assays are, for the most part, contracted out to a private laboratory. Chemistry is done by LSB. The data is used to detect changes in nearshore water quality and ecosystem structure. This program provides a measure of the impact of eutrophication and to a lesser extent, invasions of exotic species such a zebra mussels.	mid-1960's, some stations	MOEE Regions, municipal water treatment plants	0.5 (EMRB) no LSB analysis of algae	24K (EMRB)	no equivalents known	18 sites weekly, year round; algae from 13 sites are combined monthly	summaries annually and regular reporting in scientific publications	water plants, IJC, municipalities MOEE Regions

Strengths	Weaknesses	Recommended changes	Resource Implications
• large database dating to the mid-1960's • data tracks impact of changes in the lakes; e.g., introduction of zebra mussels, changes in treatment of waste water, control of farm run-off • provides back-up database for other studies involving the near-shore ecosystems • assists in quality control for LSB when methodology changes are made • year-round collections • assists in identification of taste and odour problems	• several areas along the Great Lakes shores are poorly covered: - no data for Georgian Bay - only two intakes on each of Lakes Huron and Superior - no Lake St. Clair data • QA/QC problems with contractor must be addressed; results of discussion could see significant rise in costs • only one contractor bid (May, 1994)	• continue collections, combine and sediment samples; but, archive • clients who want the data should pay for assays; • address QA/QC problems; • add collections at Owen Sound and Midland on Georgian Bay and a collection from Lake St. Clair	• sample collection is cost-effective given that water plant operators do the field work at little expense to them; sampling-related costs (EMRB) restricted to bottles, chemicals and courier services • $21K freed-up (within EMRB) by suspending assays

4. Special Biomonitoring Studies - various Branches and Sections, ESSD

Program Purpose Environmental Stressors Monitored	Year program started	In collaboration with ... (indicate lead and nature or co-operation)	Person years (estimated yearly)	MOEE ODOE (average yearly	Status of comparable programs in other jurisdictions	Number of sites and sites per year sampled	Frequency of reporting	Clients
Various sections of the ESSD provide **field monitoring support to the MOEE Operations Division** on an as needed, special request basis. The support may takes the form of: assessment of sport fish contamination, forage fish contamination, algal sampling, zooplankton sampling, caged clam studies, benthic invertebrate studies and other biota. The degree to which supporting assays or analyses are contracted outside the Ministry varies by biota. All supporting chemical analyses are provided by the LSB Environmental stresses monitored: (largely but not always) persistent toxic contaminants	not applicable	Operations Division, Environment Canada (CWS), DFO, Conservation Authorities	2 (EMRB)	$10K (EMRB)	not applicable	varies by year	reported yearly by survey in technical memoranda	Operations Division

Strengths	Weaknesses	Recommended changes	Resource Implications
• section staff are capable of high quality surveys, delivered in a timely manner • wide range of specialized techniques/methodologies are available	• coordination with biomonitoring activities by other ESSD Branches could be improved • new analytical support methods (new substances) needed	• communication between ESSD staff and Operations Division staff, both informal and formal should be enhanced to avoid overlaps and gaps in survey design. Planning sessions (e.g., teleconferences) should accompany all major surveys efforts (where more than one Section, Branch or activity are requested by Operations Division staff) • ongoing discussions required to ensure analytical services delivered in timely fashion • coordinated reports on single point sources could be written with ESSD Branches or Operations Division the lead as appropriate • LSB should develop new analytical methods (e.g., PCB congeners)	• some increased efficiencies may be possible if staff in different disciplines are trained to perform work outside their original field of training • minimal ODOE savings • the biomonitoring Section (for example) can support between 3 and 5 special requests per annum with the resources available and depending on the intensity of the work required

5. Inland Lakes Monitoring & Restoration Activities - Biomonitoring Section, EMRB, ESSD

Program Purpose Environmental Stressors Monitored	Year program started	In collaboration with ... (indicate lead and nature or co-operation)	Person years	MOEE ODOE	Status of comparable programs in other jurisdictions	Number of sites and sites per year sampled	Frequency of reporting	Clients
Biomonitoring services and technical advice are provided in support of several ongoing inland lakes restoration projects in southern Ontario. In 1994 the lakes are: Whittaker Lake, Lisgar Lake, Heart Lake, Chesley Lake, Deer Creek, Hay Creek, Little Lake. This programs addresses mainly nutrient enrichment problems in these waterbodies due to poor sewage treatment and agricultural runoff	1987	Conservation Authorities, Cottager Associations, Environment Canada (Env. Partners Fund) MNR	0.75 (EMRB)	20K (EMRB)	n/a	7 lakes, each sampled monthly	annual reports or technical memoranda	Cottager Associations: Friends of Chesley Lisgar Lake Cottagers Association Conservation Authorities: Kettle Creek MTRCA LPRCA

Strengths	Weaknesses	Recommended Changes	Resource Implications
• program provides ongoing support of restoration of economically valuable waterbodies. Successful restorations result in increased recreational use and income for local associations, municipalities and conservation authorities • restoration and monitoring techniques being developed are transferrable technology, both to the private sector in Ontario or marketable in other jurisdictions by the Ontario Government	• resources to directly fund these projects are very limited within the Ontario Government. Success depends on other to make up the short-fall. Risk that credit for these efforts will go mainly to those providing the funds	• the lake restoration and monitoring techniques being developed here are transferrable as described under "strengths" but require marketing • ongoing EMRB commitment of approximately $20K per annum seed money is needed to sustain program • program should be showcased to an international lake restoration forum to be held in Toronto in the fall, 1995. In support of this showcasing, the restoration techniques should be employed in Grenadier Pond in 1995.	• approximately $20K/annum and the commitment of one person's time

6. Fish Health Assessment - Biomonitoring Section, EMRB, ESSD

Program Purpose Environmental Stressors Monitored	Year program started	In collaboration with ... (indicate lead and nature or co-operation)	Person years	MOEE ODOE	Status of comparable programs in other jurisdictions	Number of sites and sites per year sampled	Yearly sample numbers/test codes	Frequency of reporting	Clients
To monitor aquatic ecosystem health through the integrator of fish health using the parameters of fish growth rates, fecundity, external and internal lesions, tumours, parasites, anomalies and deformities and biomarkers such as bioassay testing of fish liver function to determine the presence and significance of discharges of persistent and non-persistent toxic substances. To develop and steamline biomarker/bioassay test protocols for routine use by MOEE for watershed/subwatershed ecosystem health assessment.	1990	MNR (fish collection). MTRCA (fish collection). previous joint work with DFO (P&P studies)	0.8 (EMRB)	10K (EMRB)	Federal F&O used on Pulp and Paper Mill Assessment in Ontario and Quebec. Used in Germany and Sweden to assess Pulp and Paper and other industrial pollution sources.	25-30	Contaminant samples are submitted under Sport Fish Testing program allotment. EMRB staff will analyse 375-400 EROD bioassays, 375-400 scale samples, and other miscellaneous biological samples. 25-30 histological samples will require preparation and analysis by U. of Guelph pathologists.	semi-annual progress reports, technical memos, MOEE reports, scientific papers, briefing notes	MOEE management MOEE Operations Div., RAPs, Waterfront Trust, MNR.

Strengths	Weaknesses	Recommended Changes	Resource Implications
• bioassay of fish liver function is an emerging technology capable of detecting non-bioaccumulative toxic substances. It does not rely on high cost specific chemical analysis done by other agencies. • fish health assessment can be carried out in conjunction with other types of surveys (contaminant, fish population census) to reduce collection costs.	• interpretation of bioassay results are not chemical specific at present and require further coordinated work with Aquatic Toxicity, SDB, to determine the chemicals which contribute to particular endpoints. • prior to 1994 only two species of fish had been used for large scale investigations. • prior to 1994, collection of samples by MOEE Staff was highly labour-intensive.	• 1994 surveys have expanded the range of species evaluated to six including three sport and three coarse species. • 1994 sampling and fish autopsy has been carried out with less than half of the labour used in 1992 and 1993 surveys. Subsequent laboratory analysis will also attempt to use less than half of the previous labour required. Sampling was improved by adding electrofishing capability, autopsy was speeded by a better fish handling/laboratory system.	• 1992-93 resources were 32 person-months in each fiscal year, 1994 resources are 10-11 person-months over the fiscal year. Collection frequency and effective sample load for EROD assay and fish aging remain the same.

7. Terrestrial Standards Development, Sub-Project Ontario Typical Range - Phytotoxicology Section, SDB, ESSD

Program Purpose Environmental Stressors Monitored	Year Program Started	In collaboration with ... (indicate lead and nature or co-operation)	MOEE Person years	MOEE ODOE	Status of Comparable Programs in Other Jurisdictions	Number of sites and sites per year sampled	Frequency of Reporting	Clients
Development of background-based terrestrial standards/criteria to support MOEE policy initiatives (e.g. Materials Management, Decommissioning; also provides benchmark data for terrestrial impact assessments. This program monitors: Urban Environmental Quality and Toxic Contamination	OTR program started in 1991; consolidation of standards setting in 1993	AECL is providing radiological analysis of selected samples	0.5 (SDB) 4 (LSB)	$9K (SDB) $41K (LSB)	MOEE is at forefront of methodology development; CCME is considering same methods for application across Canada for soils; US jurisdictions showing interest in using same approach for soils; staff expertise requested to support F/P criteria document development in area of terrestrial effects	About 650 OTR sites Average of 160 sites per year	Periodic, unscheduled updates as new OTR categories are added	Operations Division Public Federal Gov't. CCME Industry Other Mins. Provinces Consultants

Strengths	Weaknesses	Recommended Changes	Resource Implications
Leadership in this area is recognized provincially, nationally and internationally Data that have been collected to date are valid and scientifically defensible Data have multiple uses for diagnostic interpretations, exposure assessment (standards), abatement/enforcement and SOER	The database currently available is still limited with respect to land use classes, soil/vegetation types Data for edible plants (vegetables and fruits) in home gardens requested to support standards development has not been collected The database for organic compounds is especially limited Detection limits used in developing the background guidelines for organic chemicals can not always be met in routine laboratory test procedures. Expertise is limited in areas not involving plants directly (i.e. animal/wildlife studies).	Renewed financial/laboratory support in the form of analytical test loads, especially for organic chemicals, is needed. More-sensitive analytical detection limits are needed for organic chemicals on a routine basis. Analytical test load reductions in public complaint investigations and non-point source assessments are being directed into the OTR program.	Retirement of two staff members in 1994 and cancellation of positions has reduced capabilities in field sampling.

8. Terrestrial Effects Assessment - Point Sources - Phytotoxicology Section, SDB, ESSD

Program Purpose Environmental Stressors Monitored	Year Program Started	In collaboration with ... (indicate lead and nature or co-operation)	MOEE Person years	MOEE ODOE	Status of Comparable Programs in Other Jurisdictions	Number of sites and sites per year sampled	Frequency of Reporting	Clients
Under agreement with OD, to investigate soil/vegetation contamination in the vicinity of known or suspected sources of air/soil borne contaminants in SW, WC, Central and Eastern Regions to support their abatement and enforcement activities. Also to provide emergency response to spills and contaminant releases re vegetation/soil contamination and to assist OD in the development and implementation of soil clean-up programs. This program monitors the effects of Toxic Contamination and Urban Environmental Quality	1969		3.5 (SDB) 4 (LSB)	$57K (SDB) $28K (LSB)	No equivalent programs in other jurisdictions are known. Other environment agencies contract work to consulting groups/academia as deemed necessary.	Total surveys from 1968 to 1993 is 1281, but does not distinguish multi-year studies About 400 sample stations visited per year.	Single issue reports (about 30-40 per year) or annual reports for multi-year studies	OD Public Industry Academia Consultants

Strengths	Weaknesses	Recommended Changes	Resource Implications
Expertise of staff is recognized provincially and internationally Terrestrial assessment is an inexpensive method to monitor compliance with Cs of A, assess need for air monitoring or locating monitors Investigations and publication of investigation results by non-regional staff viewed as independent/bias-free assessment by public/industry	Requests for certain multi-year studies are not always scientifically warranted but are often requested to satisfy public pressure groups while other more valid problems are left unattended. Pressures for fast report preparation and reduced cost for publication leads to unpublished reports (internal and technical memos) thus resulting in diminished value of reports and decrease in bias-free status of Section.	Continued sampling to satisfy political pressures should be discouraged and thereby allow staff to properly investigate other more pressing environmental problems Client service tracking and reporting on a quarterly basis to keep clients aware of investigation status has been initiated to improve service.	Loss of two staff and potential loss of two more over next year will seriously reduce delivery of program in future if vacancies are not filled.

9. Terrestrial Effects Assessment - Public Complaints - Phytotoxicology Section, SDB, ESSD

Program Purpose Environmental Stressors Monitored	Year Program Started	In collaboration with ... (indicate lead and nature or co-operation)	MOEE Person years	MOEE ODOE	Status of Comparable Programs in Other Jurisdictions	Number of sites and sites per year sampled	Frequency of Reporting	Clients
To investigate and report on public complaints re alleged impacts on soils, vegetation and domestic livestock. Requests arise directly from public or are re-directed to SDB from ROD. Findings serve as basis for regional abatement or enforcement activity, remedial action and notification of health officials re contamination of surface soils and crop/ garden produce. Service of a Board of Negotiation to assist in mediation of claims for damages to private property are also provided on request. This program monitors the effects of Toxic Contamination and Urban Environmental Quality	1969		2.0 (SDB) 0.3 (LSB)	$20K (SDB) $1.7K (LSB)	No equivalent programs in other jurisdictions are known; reliance on legal suits and court actions initiated by complainants	Estimated 4600 properties/ sites examined since 1969 Now averaging slightly over 100 per year	Single issue reports (about 100-125 per year)	Public OD Consultants

Strengths	Weaknesses	Recommended Changes	Resource Implications
Expertise of staff is recognized provincially and internationally Complaint investigations frequently the only mechanism to alert MOEE to problem industries/sources that require abatement attention	Difficulty in resolving neighbour disputes in regards to culpability in any legal proceedings. In many cases, public is not aware of their rights/access to investigative services available through the EPA nor of Board of Negotiation services to assist in compensation for environmental damage to property. The lack of database storage of this type of analytical data means that investigations are conducted each year without consideration of results that may be available from other properties in the area that could reduce the need for an investigation. This has implications for the resources required to sample as well as analyze (LSB) these types of samples.	Need for more definitive criteria in declining to accept complaints involving neighbour disputes, real estate transactions, general public concern re environmental degradation. Need to electronically capture historical data for GIS application/ SOER and for responding to general concern type requests from the public as anticipated with development of PIMS program.	Current loss of two staff and anticipated staff retirements over next year will seriously reduce delivery of program in future if vacancies are not filled.

10. Terrestrial Effects Assessment - Non-point Sources - Phytotoxicology Section, SDB, ESSD

Program Purpose Environmental Stressors Monitored	Year Program Started	In collaboration with ... (indicate lead and nature or co-operation)	MOEE Person years	MOEE ODOE	Status of Comparable Programs in Other Jurisdictions	Number of sites and sites per year sampled	Frequency of Reporting	Clients
Assessment and documentation of current status of the terrestrial environment as part of the long-term impacts of acidic precipitation, ozone and other toxic pollutants on the terrestrial ecosystems of Ontario in support of intergovernmental air quality initiatives/accords. For some studies, arrangements are made to maintain the capability of re-assessing these situations in co-operative studies with other ministries. This program monitors: Acidification, Ground Level Ozone, Urban Environmental Quality, Radionuclides	1969	Ministry of Natural Resources	2.0 (SDB) 0.75 (LSB)	$4.2K (SDB) $5.6K (LSB)	Monitoring of tree health at some Canadian sites is conducted by Forestry Canada through the ARNEWS program that provides only limited coverage and is not environmentally oriented. Sites operated under NAMP (North American Maple Program) were set up to monitor rates of change and do not define causal agents. Other jurisdictions usually conduct assessments through contracts set up with consultants, university teams and research institutions.	Extremely variable from year to year. Total sites about 4000	Periodic, unscheduled Attempting to summarize findings in journal papers.	OD Industry Other Mins. Other Prov. Scientific community

Strengths	Weaknesses	Recommended Changes	Resource Implications
Dedicated highly-qualified staff Many years of collective experience Expertise of staff is recognized provincially and internationally Detection of "hot-spots" through these studies occasionally identify previously unknown localized problems	Lack of support/direction for acquisition of expertise or conduct of assessments of special areas such as climate change, UV-B radiation, radioactivity, as mandate to do such work is has not been clarified Many subtle effects of atmospheric emissions to the terrestrial environment require long-term trend analysis of analytical chemistry and of other types of community response; the programs currently operated tend to emphasize the chemical quality aspects, with only marginal effort at examining other ecological end-points. These types of studies are usually the first to be cut during periods of fiscal restraint, as they have no short term deliverables. The success/failure of emission control programs both here and in neighbouring Provinces/US States for long-range transported pollutants and will be difficult to assess without these types of studies.	Re-arrangements of federal/provincial jurisdictions in near future may involve re-assignment of responsibilities in area of environment. MOEE staff should be prepared to undertake these responsibilities. Activities of staff originally hired under these programs has been shifted to other high priority areas (soil standards, point source assessments, OTRs).	Anticipated staff retirements over next year will seriously reduce future program delivery as staff will have to be re-assigned to other higher priority projects.

11. Great Lakes Screening Level Investigations - Surface Water Section, EMRB, ESSD

Program Purpose Environmental Stressors Monitored	Year program started	Lead Group, in collaboration with...	Person years	ODOE	Status of comparable programs in other jurisdictions	Number of sites and sites per year sampled	Frequency of reporting	Clients
Purpose: to evaluate local water quality conditions and identify emerging problems, as part of the provincial commitment under the **Canada Ontario Agreement Respecting the Great Lakes Basin Ecosystem** (COA) objective to Prevent and Control Pollution; to provide support for regional office investigations into the impacts of regulated discharges, under the **Environmental Protection Act** (EPA) and the **Ontario Water Resources Act** (OWRA); to determine compliance with jurisdictional control requirements and with provincial and **Great Lakes Water Quality Agreement** (GLWQA) objectives and guidelines and the need for *remediation*. Description: *monitoring* of biota, sediment, water and discharges at Great Lakes embayments and harbours (outside RAP areas) and at Great Lakes tributary mouths for evidence of toxic contamination, eutrophication, physical substances stress, biological diversity, presence of exotic species and microbial contamination (as appropriate).	1981	MOEE/EMRB/SWS, in cooperation with MOEE Operations Division	0.2 (SWS-EMRB) 0.4 (SMS-EMRB) 1.5 (LSB)	$24K (SMS-EMRB) $42K (SWS-EMRB) for contracts $11K (LSB)	complementary environmental assessment work is conducted by MOEE Operations Division, Environment Canada, etc.	high year to year variation 25 to 30 sites (~10 per lake) 4 to 5 sites sampled per year, each with 68 stations.	one time report. more than a one time report. regular or continuous report.	Operations Division, MNR, Federal Government (COA), Non-government Organizations, Public, Municipalities, Industry, Consultants, Academia

Strengths	Weaknesses	Recommended Changes (re: Weaknesses)	Resource Implications (re: Adjustments)
1. designed to identify emerging contaminants or biological issues.	1. usually there is insufficient data or detail for rigorous statistical testing.	1. none, without additional resource commitments or reducing the number of areas/stations sampled per year	1. effort and coverage are proportional to available resources
2. studies are tailored to local conditions.	2. specificity of information from different areas prevents ready summarization or comparison across the Great Lakes for State of the Environment reporting.	2. none	2) none
3. sampling is problem and site specific (e.g., stations, parameter selection, etc.).	3. variability in experimental design for different areas.	3. none	3) none
	4. areal coverage is very spotty and somewhat ad hoc (e.g., no routine program for all of the Great Lakes nearshore).	4. none, without enhancing budget or reprioritizing areas	4) effort and coverage are proportional to available resources
	5. utilization of results and recommendations by Operations Division is variable.	5. requires corporate (MOEE) changes in the translation of findings into remedial actions	5) unknown

12. Great Lakes Remedial Action Plans - Surface Water Section, EMRB, ESSD

Program Purpose / Description	Year program started	Lead Group, in collaboration with...	MOEE Person years	MOEE ODOE	Status of comparable programs in other jurisdictions	Number of sites and sites per year sampled	Frequency of reporting	Clients
Purpose: to document environmental conditions, define problems, and assess the effectiveness of remedial and preventative measures as part of the provincial commitment under the **COA** objectives to Restore Degraded Areas, Prevent and Control Pollution, and Conserve and Protect Human and Ecosystem Health; to provide support for regional office investigations into the impacts of regulated discharges under the **EPA** and the **OWRA**; to determine compliance with jurisdictional control requirements and with provincial and **GLWQA** objectives and guidelines and the need for additional *remediation*. Description: *monitoring* of biota, sediment, water and discharges for evidence of toxic contamination, eutrophication, physical substances stress, biological diversity, presence of exotic species or microbial contamination (as appropriate); in support of *remediation* through the federal provincial Remedial Action Plan program at the 17 Ontario (or binational) Areas of Concern.	1986 (began in late 1970s with IJC "Problem Areas")	MOEE/EMRB/SWS, in cooperation with MOEE Operations Division and Environment Canada	0.3 (SWS-EMRB 1.0 (SMS-EMRB 2.5 (LSB)	$50K (SWS-EMRB) contracts (through PDB) $46K (SMS-EMRB) $18K (LSB)	Environment Canada conducts Great Lakes studies in open waters and connecting channels.	17 Areas of Concern, about 6 sites sampled per year 10 to 100 stations per site (AoC)	one time report more than one time report regular or continuous report	Operations Division, MNR, Federal Government (COA), Non-government Organizations, Public, Municipalities, Industry, Consultants, Academia

Strengths	Weaknesses	Recommended Changes (re: Weaknesses)	Resource Implications (re: Adjustments)
• studies are tailored to local conditions, with adequate areal coverage. • sampling is problem and site specific (e.g., stations, parameter selection, etc.). • studies responding to local needs and priorities. • tied in to remedial measures (RAP Stage 2 & 3 needs) • results in raised public involvement and expectations regarding environmental improvement	1) specificity of information from different areas prevents ready summarization or comparison across the Great Lakes for State of the Environment reporting 2) variability in experimental design for different areas. 3) areal coverage is somewhat arbitrary (e.g., Collingwood vs. Whitby Harbour). 4) requires a high allocation of resources to support RAP Stage 2 and 3 requirements. 5) extensive public and stakeholder involvement may delay project and/or application of study results.	1) none 2) none 3) priority setting methodology required 4) priority setting methodology required 5) MOEE is committed to public involvement	1) none 2) none 3) effort and coverage are proportional to available resources 4) effort and coverage are proportional to available resources 5) none

13. Long Term Sensing Sites - Surface Water Section, EMRB, ESSD

Program Purpose / Description	Year program started	Lead Group, in collaboration with...	Person years	ODOE	Status of comparable programs in other jurisdictions	Number of sites and sites per year sampled	Frequency of reporting	Clients
Purpose: to evaluate local and whole lake water quality trends, identify emerging problems, evaluate the health of the aquatic environment, identify and track background conditions, and determine compliance with provincial and **GLWQA** objectives, as part of the provincial commitment under the **COA** objectives to Conserve and Protect Human and Ecosystem Health and to Control and Prevent Pollution. Description: regular *monitoring* of biota, sediment and water quality at 48 index stations (sites) located throughout the Great Lakes and their connecting channels on a four year cycle (i.e., one water body/year) for evidence of toxic contamination, eutrophication, physical substances stress, biological diversity, presence of exotic species and global warming (as appropriate).	1989	MOEE/EMRB/SWS, with input from MOEE Operations Division	0.2 (SWS-EMRB) 0.5 (SMS-EMRB) 1.0 (LSB)	$35K (SWS-EMRB) Contracts $37K (SMS-EMRB) $8K (LSB)	complementary surveillance work is conducted by other agencies, but differs either in geographical focus, type of information collected, or in monitoring approach	48 sites (stations) in all 5 to 16 sites/stations sampled per year	regular or continuous report.	MOEE (SOE Reporting, LAMPs) MNR Federal Government (COA, LAMPs) Consultants Academia

Strengths	Weaknesses	Recommended Changes (re: Weaknesses)	Resource Implications (re: Adjustments)
• designed for interyear trend assessment of Great Lakes environmental conditions. • permits the early detection of subtle changes in environmental conditions which may predate major changes (e.g., emerging contaminants or biological issues) • provides an integrated set of environmental measurements which can be used to more holistically interpret environmental change. • provides information on intrayear variability to better enable interpretation of interyear variation of biological and chemical data. • provides a modest amount of reference or background information on a regional basis. • mainly uses standard MOEE methods to provide information for comparison with other MOEE programs. • provides for testing of new protocols at selected sites where other environmental data is routinely collected. • provides an opportunity for inclusion and integration with other types of monitoring (e.g., air). • provides information on broadscale patterns of environmental conditions. • provides information for State of the Environment reporting and Lakewide Management Plans.	1) number of sites provides limited spatial coverage in any given area. 2) relatively high field and analytical costs. 3) requires a longterm commitment to accumulate the necessary databases for ultimate benefits. 4) database compilation, management and interpretation has high time requirements (e.g, benthic invertebrates. 5) scheduling of LTSS sampling is not very flexible. 6) some measured parameters (e.g., benthic invertebrates) currently have no standards, agreed upon objectives, criteria or indicator levels, or QA/QC approaches. 7) there is some necessary duplication of efforts of other studies due to the fixed nature of the study design. 8) there is no strategy or infrastructure to support the archiving of biological (e.g., benthic invertebrates) samples.	1) none, without additional resource commitments. 2) continuous reevaluation of the program may yield cost reductions; for example: there were recent reductions in the numbers of benthic invertebrate and sediment chemistry samples, the latter due to "non detects" in the initial surveys; statistical review of the project study design, based on patterns of variability in initial surveys; the plankton component is being evaluated to determine its suitability or benefits to the program; evaluation of new biomonitors and water monitoring systems for their applicability in background/control sites (e.g., to lower detection limits). 3) consistent resource commitment. 4) construct an integrated database. 5) none. 6) identify needs to Science & Technology and/or Standards Development Branch. 7) pursue opportunities for integration and collaboration with other similar programs in the Great Lakes Basin. 8) initiate archival program.	1) unknown. 2) modest to substantial decrease in analytical and external analytical services; possible increase in staff (PY) workload and ODOE cost for statistical services; modest increase if plankton component continued; cost and time requirements unknown at present. 3) none. 4) possible increase in staff (in house) requirements and/or ODOE cost for external services. 5) none. 6) unknown. 7) modest increase in staff (PY) time. 8) modest increase in staff (PY) time and allocation of dedicated storage area.

14. Muskoka Lakes Plankton Study - Aquatic Science Section, STB, ESSD

Sub-program title, where applicable	Program purpose and Stresses Monitored	Year program started	In collaboration with ... (indicate lead and nature or co-operation)	Person years	ODOE	Status of comparable programs in other jurisdictions	Number of sites and sites per year sampled	Yearly sample numbers/test codes	Frequency of reporting	Clients
Plankton (including separate assessment of Bythotrephes (B. c.)	Assess and predict the impacts of eutrophication, acidification, physical stress and exotic species on the plankton communities of Muskoka lakes	1993	MNR (Muskoka Lakes FAU) and Muskoka Lakes Area Office); Muskoka Heritage Foundation	0.3 (STB)	21K (STB)	Collaborative with MNR	19 sampling sites (x 7 runs/yr); 15 sites pooled for phytopl.; 4 sites biweekly for B. c.		Annual report; sci journals as required	municipalities, MNR, Public, Univers's ROD

Sub-program title, where applicable	Program purpose and Stresses Monitored	Year program started	In collaboration with ... (indicate lead and nature or co-operation)	Person years	ODOE	Status of comparable programs in other jurisdictions	Number of sites and sites per year sampled	Yearly sample numbers/test codes	Frequency of reporting	Clients
Nearshore benthos	Assess and predict the impacts of eutrophication, acidification, physical stress and exotic species on the benthic communities of Lakes Muskoka, Rosseau and Joseph; prediction of impacts and guidelines for future development	1993	MNR (Muskoka Lakes FAU) and Muskoka Lakes Area Office); MNR does complementary fish work at littoral zone sites	0.2 (STB)	6K (STB)	Collaborative with MNR (FAU and Muskoka Lakes Area Office):	24 sites once/year (late autumn)		annual report, scientific journal publications as required	munic's MNR, ROD

Strengths	Weaknesses	Recommended Changes	Resource Implications
Integrated with MNR program, hence tends to ecosystem orientation (more holistic than usual); well defined questions, objectives; integration of biological sampling (fish, benthos, plankton) with nearshore chemistry, habitat and shoreline development mapping	Many samples reduced to pooled samples because of $ constraints (individual analyses provide better data); apparent lack of corporate level support for biological analyses; limited tech. support and $	Lack of $ forces use of less qualified staff/contractors for technical tasks; sampling and statistical design suboptimal	over-qualified staff doing sample processing/sorting

15. LSEMS Implementation, Phase I - Aquatic Science Section, STB, ESSD

Program purpose and Stresses Monitored	Year program started	In collaboration with ... (indicate lead and nature or co-operation)	Person years	ODOE	Status of comparable programs in other jurisdictions	Number of sites and sites per year sampled	Yearly sample numbers/test codes	Frequency of reporting	Clients
To monitor trends associated with changes in eutrophication, physical stresses (e.g., temperature, TSS), habitat losses and exotic species in Lake Simcoe to permit setting of ecosystem objectives	1990	MNR, LSRCA, OMAFRA	0.5 (STB)	30K (STB)	Collaborative with MNR, Lake Simcoe Region CA	16 sites, 10-12 runs/yr; weekly at four water intakes	144 zooplankton and 208 phytoplankton samples	5-yr progress report; annual report; sci. journals as required	Municipalities, MNR, Public, ROD

Strengths	Weaknesses	Recommended Changes	Resource Implications
Integrated with MNR program, hence tends to ecosystem orientation; long-term data base necessary for evaluation of changes; good background for evaluation of effects of exotic species (zebra mussel and spiny waterflea).	Many samples reduced to pooled samples because of $ constraints (individual analyses provide better data); lack of control lakes of similar size; some biotic groups not studied (esp. littoral zone communities)		Need to assign a technician from the ESS Div. to the LSFAU to support the programme (MOEE scientist to be assigned in 1995).

16. Long-Range Transport - Biological - Aquatic Science Section, STB, ESSD

Sub-program title, where applicable	Program purpose and Stresses Monitored	Year program started	In collaboration with ... (indicate lead and nature or co-operation)	Person years	ODOE	Status of comparable programs in other jurisdictions	Number of sites and sites per year sampled	Yearly sample numbers/ test codes	Frequency of reporting	Clients
Stream Zoobenthos	To assess and predict the impacts of and associated recovery from acidification, contaminants and physical stresses on the benthic communities of inland streams	1984	Universities	1.0 (STB)	19K (STB)		30 streams, 120 sites	120 samples, 1100 tests	regular and sci. journals as required	Fed. Gov't, ROD, MNR, public
Littoral macroinvertebrates	To assess and predict the impacts of and associated recovery from acidification, contaminants and physical stresses on the littoral-zone benthic communities of inland lakes	1988	DFO, DOE, Universities	2.0 (STB)	37K (STB)	Collaborative with DFO, DOE, MNR	20 lakes, 100 sites		regular and sci. journals as required	Fed. Gov't, ROD, MNR, public
Lake Plankton	To assess and predict the impacts of and associated recovery from acidification, contaminants and physical stresses on the plankton communities of inland lakes	1976	MNR, ROD, Universities	2.5 (STB)	34K (STB)	Some Univ. collaboration, e.g. (York and U. of T.)	14 lakes + additional 30 (1 sample) for zoopl.		regular and sci. journals as required	Fed. Gov't, ROD, MNR, public

Sub-program title, where applicable	Strengths	Weaknesses	Recommended Changes	Resource Implications
Stream Zoobenthos	Largest stream baseline dataset in N.A.; unique on the Can. Shield; quicker response time than lakes; economically important taxa (e.g. biting flies); high biodiversity with many potential indicator species.	Large gaps in time series; limited regional survey data; limited tech. support and $; large sample backlog/ many samples archived (not analyzed)	Sample and lab loads are a function of available funds; lower priority samples are archived because of lack of $.	Understaffed; further reductions would result in further delays in program delivery.
Littoral macroinvertebrates	Large collaborative programme (DOE, DFO, MNR) in 6 regions in NE Canada; data in joint Fed/Prov. Oracle database; stress-sensitive lake zone; high biodiversity with many potential indicator species; unique in N.A.; data important for MNR FAU's.	Sampling protocols have limited QA/QC; relatively short time series; limited regional survey data; limited tech. support and $; large sample backlog/ many samples archived (not analyzed)	Sample and lab loads are a function of available funds; lower priority samples are archived because of lack of $.	Understaffed; further reductions would result in further delays in program delivery.
Lake Plankton	Very long time series; broad spatial scale; many different types of lakes; documented database (zoopl.); internationally recognized expertise; indicators with proven potential for assessing community damage and recovery	unbalanced experimental design; regional survey data out of date; too few large lakes; no littoral zone data; limited tech. support and $;	Sample and lab loads are a function of available funds; lower priority samples are archived because of lack of $.	Understaffed; further reductions would result in further delays in program delivery.

17. **Caged Fish (Field) Studies - Aquatic Toxicity Section, SDB, ESSD**

Program description	Year program started	In collaboration with ... (indicate lead and nature of co-operation)	Person years	ODOE	Status of comparable programs in other jurisdictions	Number of sites and sites per year sampled	Yearly sample numbers/test codes	Frequency of reporting	Clients
To demonstrate using caged fish at various sites, both near point sources and to monitor non-point sources, and to solve issues related to fish reproduction. This program monitors the effects of **discharges of toxic substances.**	1981	MNR/MOEE Operations Division	1.0 (SDB)	$5K (SDB)		1-2 sites/yr	small numbers varying with study	Individual reports for each study	MOEE Operations Division, Other Ministries (MNR), Federal Gov't (GLWQA Annex 11), Non-Government Organizations, Public, Municipalities, Industry, Consultants, Academia

Strengths	Weaknesses	Recommended Changes	Resource Implications
- complements the laboratory acute toxicity testing on effluents, making it possible to determine whether observations on toxicity of effluents in the laboratory also can be demonstrated in the field. - can be used in field investigations in order to control the exposures of the test animals to specific conditions - specialized caged testing can also be used to help determine causes of reproductive failure in fish populations	- It is difficult to operate field cages successfully in highly variable streams - often rain events cause heavy siltation and damage to the test animals apart from that caused by toxicants - The work is often needed by several clients at the same time to coincide with spring melt, spawning runs etc.		All of this work done by Aquatic Toxicology is now done by one person who does this work exclusively.

18. Biological Monitoring and Assessment Program (BioMAP) - Southwestern Region, Operations Division

Program Purpose Environmental Stressors Monitored	Year program started	In collaboration with ... (indicate lead and nature or co-operation)	Person years	MOEE ODOE	Status of comparable programs in other jurisdictions	Number of sites and sites per year sampled	Yearly sample numbers/test codes	Frequency of reporting	Clients
Using benthic invertebrate populations; to monitor the ecological health of streams and rivers in the Southwestern Region, MOEE. The program can monitor the effects of various environmental stresses: eutrophication, turbidity, exotic species invasions, physical stresses (e.g., temperature), acidification, hydrological alterations	1993	Conservation Authorities where appropriate (e.g., Upper Thames)	0.6 (OD)		use of benthic invertebrates is common in neighbouring states	40 (the 10 benchmark sites samples twice a year)	3 samples of invertebrates per site, per collection	summary reports, annually	public, industry, conservation authorities

Strengths	Weaknesses	Recommended Changes	Resource Implications
• the program provides good measures of general ecosystem health for specific waterbodies; • program integrates the impacts of various environmental stresses; • because counting is/can be done in the field, results are available immediately without having to wait for laboratory analyses; • program can optimize (by focusing) expensive follow-up chemical analyses; • benchmark sites provide ongoing (long term) reference; • program design is flexible to changing MOEE needs	• public may not relate to disturbances in benthic organisms as they would to changes in (e.g.) song bird populations or cross-billed cormorants.	• BioMAP offers a model for benthic invertebrate surveys throughout Southern Ontario	• for the program to achieve the projected cost savings it must be implemented in the field; specialists must be trained; • cooperating agencies/ organizations must be sought out

APPENDIX B

The attached tables represent two pages of an inventory of internal and external database prepared by the Environmental Reporting Section, EMRB. They provide an indication of the breadth of biomonitoring information available for Ontario ecosystems.

INVENTORY OF INTERNAL & EXTERNAL DATABASES - ENVIRONMENTAL ANALYSIS
ENVIRONMENTAL REPORTING COORDINATION SECTION
H/TINGOR/OPRO/DATAERC3.WQ2

October 20, 1994

MEDIA CLASS	PROJECT NAME	SUMMARY	PARAMETERS	Geog. Coverage	Length Record	Jurisdiction	Organization	CONTACT NAME	CONTACT PHONE #	KEYWORDS
AGRICULTURE	CENSUS AGRICULTURE	Data from operators of farms,ranches or other agr holdings	livestock,poultry,crops,fruits,veggies,value,expense	Ontario	> 10 yrs	Federal	SC	L. Kemp	613 951-8711	AGR,PEST,CROP
AGRICULTURE	SURVEY OF PESTICIDE USE	Estimates of pesticide use on crops, vegies	quantity of pesticide/area sprayed	Ontario	4-10 yrs	Provincial	OMAF	B. McGee	416 326-3219	AGR, PEST, GL
AGRICULTURE	CENSUS OF WILDLIFE PELT PROD.	Data on wildlife pelts produced in Canada	type of wildlife pelts, value of production,land	Ontario	> 10 yrs	Federal	SC	P. Mezaros	613 951-2505	PELTS,WDL
AGRICULTURE	AGRICULTURAL BENCHMARK SITES	Baseline data to assess soil quality changes	soil(permeability, density, compaction)	Ontario		Federal	Agr. Can	D. King	519 766-9180	
AGRICULTURE	NATIONAL FARM SURVEY	Data on agricultural sector;based on farming operations	land use,operating arr.,livestock,farm expenses	Ontario	> 10 yrs	Federal	SC	P. Steven	613 951-2435	AGR,LIVESTOCK
AGRICULTURE	ORGANIC MATTER	Organic matter in Ont.Topsoil inclu text/drain	% (sand,silt,clay), texture, drainage, pH	S. Ont	>10 yrs	Provincial	OMAF	B.van den Broek	519 767-3572	PDY,SOIL, GL
AGRICULTURE	TILLAGE 2000 ECONOMICS	Field history, operation, yield for 34 farms	crop rotation, equip use, type fertilizer	C.E.N. Ont	4-10 yrs	Provincial	OMAF	D. Aspinall	519 767-3675	AGR,CROP, GL
AGRICULTURE	TILLAGE 2000 GROWTH/YIELD	Crop growth, yields, moisture, pop., pests, diseases	#plants, height, leaf counts	C.E.N. Ont	4-10 yrs	Provincial	OMAF	D. Aspinall	519 767-3675	AGR,CROP, GL
AGRICULTURE	TILLAGE 2000 SOIL	Detailed soil profiles	soil structure, root depth, pH, drainage	C.E.N. Ont	4-10 yrs	Provincial	OMAF	D. Aspinall	519 767-3675	AGR, SOIL, GL
AGRICULTURE	SWEEP SURVEY	Document changes in tillage, conserv & cult.pract.	crops, fields, fertilizers,etc.	L.Erie Wat	1966&1981	Provincial	OMAF	P. Roberts	519 767-3578	AGR, GL
AGRICULTURE	TILLAGE 2000 RESIDUE	Crop residue for 34 farms	% crop residue	C.E.N. Ont	4-10 yrs	Provincial	OMAF	D. Aspinall	519 767-3675	AGR,CROP, GL
AGRICULTURE	PESTICIDES USED IN ONTARIO	Temporal/spatial analysis of pesticides	pesticide(amt,use),etc	Ontario		Federal	EC/EHD	J. Struger		PEST,AGR, GL
AIR	NAT'L AIR POLLUTION SUR. NETWORK	Monitoring common Air contaminants	SO2,CO,O3,NO2,Pb,Nitrates,Sulphates	Ontario	> 10yrs	Federal	EC/EP	J. Shelton	613 991-9453	AQ,ENVM,POLL
AIR	GREAT LAKES TOXIC DEPOSITION	To quantify atm loadings into Gr. Lakes	PCBs, PAHs,pesticides, metals,etc	Ontario	> 10yrs	Provincial	MOEE	M. Shackelton	416 323-5153	AQ, CON, GL
AIR	RADIATION PROCTECTION	Measurement of radiation source	X-ray inventory, #rad sources	Ontario	n/a	Provincial	MOL	J. Barry	416 326-7133	RADN,HHE,GL
AIR	CAN AIR & PRECIP MON NETWORK	Sampling air & precip,meter pars for acidifying air poll/ozone	chemicals, inorganics for air/precip	Ontario	< 10yrs	Federal	EC/MARD	M. Phillips	416-739-4449	AP,APOL,AQ,OZ
AIR	VOLATILE ORGANIC COMPOUNDS	Quantify VOCs in urban areas	36 VOC compounds	Ontario	4-10 yrs	Provincial	MOEE	P. Steer	416 3235091	AQ, CON, GL
AIR	INTEGR. ATM. DEP. NETWORK	Provide mass/balance toxics to Gr.Lakes	metals/trace organics in air/prec.	Gr. Lakes	< 3yrs	Federal	EC/AES	A. McMillan		ATM, PRECIP
AIR	PAHs MONITORING	Air data on PAHs in urban areas	33 selected PAHs	Ontario	4-10 yrs	Provincial	MOEE	G. Diamond	416 323-5212	CON,GL,TXCHEM
AIR	AGR. AGROCLIMATOLOGY	Climatic data examining shifts in climate patterns	air temp, soil temp, rel hum, wdir, wspd	S. Ont	>10 yrs	Provincial	OMAF	W. Roberts	519 767-3168	AGR,TECH,TOUR
AIR	AIR POLLUTANTS COMPENDIUM	Info on air pollutants on economic sector & prov. basis	hydrocarbons,particulate,inorganics	Canada	> 10yrs	Federal	EC/EPCP	T. Furmanczyk	819 994-3128	EMS,AQ,APOL,M
AIR	ACID PRECIPITATION IN ONTARIO	Quantification of atmospheric loadings of acids	Precip(amt,metals,pH), air(SO2,metals)	Ontario	> 10yrs	Provincial	MOEE	D. Orr	416 323-5177	AP, CON, GL
AIR	RESIDUAL DISCHARGE INVENTORY SYS.	Dbase of emission estimates for pollutants from other sources	SO2,NO,CO,HC,NH3,particulate matter,VOC	Ontario	> 10 yrs	Federal	EC/PDAD	M. Deslauriers	819 994-3069	EMS,IND,MV,
AIR	ONTARIO EMISSION INVENTORY	Emission inventories of point/areas sources	SO2, NOx, CO, THC, part., toxics	Ontario	> 10yrs	Provincial	MOEE	P. Wong	416 235-6130	EMS,ENV SC,GL
AIR	PCDD/PCDF MONITORING	Air data for PCDD/PCDF	toxic congeners	Ontario	4-10 yrs	Provincial	MOEE	P. Steer	416 323-5091	AQ, CON, GL
AIR	COMPLAINTS, SPECIAL STUDIES	Adverse impacts on property, veg, soil, & health	Vegetation, soil, health, ;roperty	Ontario	< 1yr	Provincial	MOEE	n/a	n/a	AIR,SOIL,HE
AIR	ONT. HOSPITAL ADMISSIONS & AIR QUAL.	Daily #s of hosp admission/info on ambient air pollution	sulphates,nitrates,SO2,NO,ozone,respiratory illness	Ontario	> 4yrs	Federal	HWC	R. Burnett	613 954-0170	AQ,HE,APOLL
AIR	AIR QUALITY INFORMATION	Gaseous/particulate/meteorological data	gases, AQI, API, particulates, metals, wind	Ontario	> 10yrs	Provincial	MOEE	P.K. Misra	416 235-5768	AQ, CON, GL
AIR	MULTI-CITY ACID AEROSOL STUDY	Study on respiratory cond & air quality in Can & Ame cities	air & indoor env. quality, respiratory illness	Ontario	> 4 yrs	Federal	HWC	M Raizenne	613 957-1878	AP,AQ,HE
AIR/PRECIP	NATIONAL ATMOSPHERIC CHEMISTRY	Air and precipitation chemistry data	Prec:wet collectors,sampling,Air:filter,nylon,teflon,	Ontario	> 10 yrs	Federal	EC/AES	M. Phillips	416 739-4449	AP,AQ,PREC
AVIATION	ENVIRONMENTAL SCREENING SYSTEM	Consultative sys of environmental information for Can airports	terrestrial & aquatic animals,habitat,soil,atmosph	Ontario	> 10 yrs	Federal	TC	A. Simpson	613 990-0512	ENV.ASSESS
AVIATION	ENV. ASSESSMENT & REVIEW PROCESS	Environmental screening decisions for all Airport Grp. Proj.	record,project number,airport,fiscal year,description	Ontario	> 10 yrs	Federal	TC	R. O'Brien	613 990-1402	ENV ASSESS
BIOM	IMPOR OF WILDLIFE TO CANADIANS	Data from Can. on their wildife activities & expenditures	wildlife act.,attitude,type,grps,personal info (age	Ontario	4-10 yrs	Federal	EC/CWS	A. Haining	613 951-4592	WLD,BDR WATC
BIOM	BIRD BANDING & REC. DATABASE	Bird banding & bird recovery across Canada & USA	birds species,attributes, banding,recovery	Ontario	> 10yrs	Federal	EC/MBSD	E. Hayakawa	819 953-1425	BIO,BRDS,WDL
BIOM	AVIAN USE OF AGROHABITATS	Birds species comp. of habitats in agr. landscapes in GL.	birds species, species activities,habitat des.	GL, S. Ontario	> 10yrs	Federal	EC/MBSD	K. Freeman	819 997-6082	BIO,BRDS,HAB
BIOM	FRESHWATER PLANKTONIC INVER. DBAS	Bibliography on freshwater planktonic invertebrates	biochem,ecology,fisheries,pathology,bibliography	Ontario	> 10 yrs	Federal	CMN	R. Chengalath	613 954-4958	AECO,BIO,WA
BIOM	BIOLOGICAL/CONSERV. SYS.	Databases on rare plants/animals,plant commun.	plant/animal spcies, plant commun.	Ontario	4-10 yrs	Provincial	MNR	I. Kirkham	705 745-8307	ENDSP,WDL,GL
BIOM	DEER WINTER FEEDING	Diet/methods used to feed deer in emerg.	feeding types, behaviour, techniques	Ontario	4-10 yrs	Provincial	MNR	D. Voight	905 832-7247	MAMM,WDL,GL

ENVIRONMENTAL REPORTING COORDINATION SECTION

H/TINGOR/QPRO/DATAERC3.WQ2

October 20, 1994

MEDIA CLASS	PROJECT NAME	SUMMARY	PARAMETERS	Geog. Coverage	Length Record	Jurisdiction	Organization	CONTACT NAME	CONTACT PHONE #	KEYWORDS
BIOM	IMPOR OF WILDLIFE TO CANADIANS	Data from Can. on ther wildlife activities & expenditures	wildlife act.,attitude,type,grps,personal info (age	Ontario	4-10 yrs	Federal	EC/CWS	A. Herring	613 951-4592	WLD,BOR WATCH
BIOM	BIRD BANDING & REC. DATABASE	Bird banding & bird recovery across Canada & USA	birds species,attributes, banding,recovery	Ontario	> 10yrs	Federal	EC/MBSD	E. Hayakawa	819 953-1425	BIO,BRDS,WDL
BIOM	AVIAN USE OF AGROHABITATS	Birds species comp. of habitats in agr. landscapes in GL	birds species, species activities,habitat des.	GL, S. Ontario	> 10yrs	Federal	EC/MBSD	K. Freeman	819 997-6082	BIO,BRDS,HAB
BIOM	FRESHWATER PLANKTONIC INVER. DBASE	Bibliography on freshwater planktonic invertebrates	biochem,ecology,fisheries,pathology,bibliography	Ontario	> 10 yrs	Federal	CMN	R. Chengalath	613 954-4958	AECO,BIO,WA
BIOM	BIOLOGICAL/CONSERV. SYS.	Databases on rare plants/animals,plant commun.	plant/animal spcies, plant commun.	Ontario	4-10 yrs	Provincial	MNR	I. Kirkham	705 745-8307	ENDSP,WDL,GL
BIOM	DEER WINTER FEEDING	Diet/methods used to feed deer in emerg.	feeding types, behaviour, techniques	Ontario	4-10 yrs	Provincial	MNR	D. Voight	905 832-7247	MAMM,WDL,GL
BIOM	AQUATIC INVERTEBRATE	Aquatic habitat inventory in streams/rivers	invertebrates, chemical, physical, biol.	Ontario	> 10yrs	Provincial	MNR	G. Gale	416 314-1320	RIV,WDL,INSECTS
BIOM	ATLAS (SPECIES NAME) LAKES	Lake listings of fish(walleye,lake trout,bass,pike)	fish species, lake char, survey status	Ontario	4-10 yrs	Provincial	MNR	F. McNeil	905 832-7292	BIO,FSH, GL
BIOM	GENERAL INVERTEBRATES DBASE	Data on gen. invertebrates Can Museum of Nature collection	taxonomy,geo info,habitat,preservation & conservatio	Ontario	> 10 yrs	Federal	CMN	R. Chengalath	613 954-4958	BIO,INVER
BIOM	ONTARIO HERONRY INVENTORY	Information on the heron bird colony	colonies (size/number)	S. & E. Ont	4-10yrs	Local	Long Pt Club			HERONS
BIOM	BUTTERFLIES OF ONTARIO	Butterflies and summaries of Lepidopters		Ontario		Local	Local Club	Tor.Entomolog.		BUTTERFLIES
BIOM	ONTARIO BIRDS AT RISK	Monitor vulnerable, threatened, scarce birds	red-should.hawk,loggerhead shrike	Ontario	< 3yrs	Local	Long Pt Club		519 586-3531	BRDS,ENDSP
BIOM	NATIONAL HARVEST SURVEY	Info on hunter activity & migratory game bird kill	Fed. migratory bird kill (species,age,sex), activity	Ontario	> 10yrs	Federal	EC/CWS	E. Hayakawa	819 953-1425	BIO,BRDS,MBRDS
BIOM	MIGRATION MONITORY	Long term population monitoring	# birds at migration points	localized	> 10yrs	Local	Long Pt Club	J. McCracken	519 586-3531	BRDS,MIGR.
BIOM	MAY BREEDING POP SUR-WAFOWL	Estimates of breeding waterfowl by species & strata	ponds,# wafowl by species,#coots,#Ca G	Ontario	> 10yrs	Federal	EC/CWS	D. Caswell	204 983-5260	BIO,WLD,MBRDS
BIOM	MIGRATORY GAME BIRD POP STATUS	Pop size/habitats cond of waterfowls across N. America	pop species in various seasons, pond counts	Ontario	> 10yrs	Federal	EC/CWS	K. Dickson	819 9531415	BIO,MBRDS,WDL
BIOM	LRTAP BIOMONITORING SITES	Info waterfowl prod, water chem, fish status,morpho data	biobc:fish status,den, aqua:pH,ions,Org Ca	Ontario	> 10yrs	Federal	EC/CWS	D. McNicol	613 952-2409	AP,GIS,HAB,WDL
BIOM	CHRISTMAS BIRD COUNT	Monitor changes in dist. of wintering birds	# of each species,# observers,etc.	Ontario	> 10yrs	Local	Local Club			WINTER BRDS
BIOM	HAWKWATCHING	Population trend of diurnal raptors	# birds at migration pts.	localized		Local	Local Club	Various	519 434-5884	HAWKS, MIGR.
BIOM	FISH COMMUNITY SYNTHESIS	Summarized data on lake trout fish communities	catch stats, population attributes,etc	Ontario	> 10 yrs	Provincial	MNR	R. Korver	905 832-7130	FSH,WDL,GL
BIOM	FISH SPECIES DISTRIBUTION	Province-wide fish species distribution	fish, species, rare/endangered	Ontario	> 10yrs	Provincial	MNR	G. Gale	416 314-1320	FSH,WSDS,WDL
BIOM	DENDROCHONOLOGY STUDY	Tree growth charact. for sugar maple/red pine	tree/soil characteristics	S.&C. Ont	4-10 yrs	Provincial	MOEE	R. Pearson	416 323-5102	BOT, TREE, GL
BIOM	FISH POPULATION ANALYSIS	Summary database of fish species/group	stream assess/productivity, fish species	Ontario	4-10yrs	Provincial	MNR	Senior Planner	416 314-1320	BIO,FSH,GL
BIOM	WILDLIFE HEALTH RESEARCH	Data on parasites/toxins in wildlife	moose, ticks, mink/wolf parasites,etc	Ontario	> 10yrs	Provincial	MNR	E. Addison	416 832-7108	HE,WDL,GL
BIOM	FISH STOCKING	Support policy/partnership Gr. Lakes Commis	fish species, age, size, dev.stage,etc	Ontario	> 10yrs	Provincial	MNR	P. Hulsman	705 740-1531	FSH,WDL,GL
BIOM	TORONTO LEAD SURVEY	Assess lead levels in veg./soil for trans. corridor	lead + metals, shrub foliage, soil	Metro Tor.	> 10yrs	Provincial	MOEE	R. Pearson	416 323-5102	CON,SOIL, GL
BIOM	HAZARDOUS WASTES INVENTORY	Monitor transfer hazardous/liquid ind. wastes	co.(name,loc), waste(type,quant)	Ontario	4-10 yrs	Provincial	MOEE	W. Tse	416 314-7994	WSTE,CON, GL
BIOM	POLAR BEAR RESEARCH	Tracking background info on polar bears	polar bear size/movement, reprod.	Hud/Jame Bay	> 10yrs	Provincial	MNR	M. Obard	905 832-7132	MAMM,WDL
BIOM	TOXICS IN TERRESTRIAL ENV.	Background chemistry for urban/rural soils	PAHs, PCBs, dioxin/furans, DDT,etc	S. Ont	< 3yrs	Provincial	MOEE	R. Pearson	416 323-5102	CON,SOIL, GL
BIOM	WILDLDIFE INFORMATION	inventory of wildlife	life history, habitat, food,etc	Ontario	> 10yrs	Provincial	MNR	F. McKay	416 314-1041	ECO, MAMM,GL
BIOM	YOUNG OF YEAR (FORAGE) FISH	Monitor non-migratory fish for source of discharges of con.	chemical, PCBs,DDT, metabolites	Ontario	> 10yrs	Provincial	MOEE	K. Suns	416 235-5796	CON, FSH
BIOM	SOIL BASELINE CHEMISTRY	Baseline soil data to assess acidic precip.	texture, pH, total N, metals,etc	Ontario	4-10yrs	Provincial	MOEE	R. Pearson	416 323-5102	CON,SOIL,GL
BIOM	BLACK BEAR RESEARCH	Studying habitat types for harvest determination	Pop., harvest, habitat, food avail	N. Ont	>10 yrs	Provincial	MNR	M. Obard	905 832-7132	HAB,WDL,GL
BIOM	FIELD CROP OXIDANT INJURY	Assess ozone acute toxicity to tomato,potato,bean	reated toxicity symptoms, cultivar	S. Ont	n/a	Provincial	MOEE	R. Pearson	416 323-5102	
BIOM	SPORT FISH CONTAMINANT	Results from sport fish sampling	species(length,wt,ht), Hg, PCBs,etc	Ontario	> 10yrs	Provincial	MOEE	C. Cox	416 314-7901	CON, FSH, GL
BIOM	HISTORICAL FOLIAR SULPHUR	Red/white pine,aspen/paper birch foliage	species, foliar chemistry	Sudbury	n/a	Provincial	MOEE	R. Pearson	416 323-5102	AP, BOT, GL
BIOM	TREE SEEDLING PLOT	Monitor response of tree seedling to acidic precip.	tree(crown,diameter),foliage, soil	NE. Ont	> 10yrs	Provincial	MOEE	R. Pearson	416 323-5102	AP, BOT, GL
BIOM	ONTARIO TYPICAL RANGE	Background soil/veg data	metals, PAHs, PCBs, dioxins/furans,pH	Ontario	4-10yrs	Provincial	MOEE	R. Pearson	416 314-5102	BOT,PLANTS, GL
BIOM	LICHEN AND MOSS CHEMISTRY	Lichen/Moss chemistry data	lichen/moss species, metals	Ontario	< 3yrs	Provincial	MOEE	R. Pearson	416 323-5102	BOT,PLANTS, GL
BIOM	GREAT LAKES BIOL. TISSUE	Data on analyses/storage of fish specimens	Specimen(age,wt,sex,lgth),quantity)	Gr Lakes	> 10yrs	Federal	DFO	W. Hyatt	416 336-4961	BIO,GL,FSH,TISS
BIOM	BREEDING BIRD SURVEY	Determine changes in breeding bird population	roadside habitats	Ontario	> 10 yrs	Federal	CWS	M. Cadman	519 766-1696	BRDS, HAB
BIOM	MAMMALOGY	Mammal specimen records	species(location,breeding), habitat	Ontario	> 10yrs	Provincial	ROM		416 586-5766	BIO,MAMM,GL

Appendix 1 Goals and Objectives of Monitoring and Reporting

Goal of Monitoring

To assess and report on the state of Ontario's environment, in support of informed decision-making that leads toward the restoration and maintenance of the province's ecosystems.

Objectives of Monitoring

- The Ministry will focus its monitoring and reporting efforts on assessing the state of Ontario's environment, while recognizing the need for ongoing compliance monitoring.
- The Ministry will contribute towards sustainability reporting by integrating reporting on the state of the environment with the broader economic and social issues.
- The Ministry will provide information on the state of the environment to be used as an integral part of Ministry, and inter-Ministry priority-setting for environmental protection.
- The Ministry will take a leadership role with other Ontario Ministries and jurisdictions in the development of a truly integrated provincial monitoring and reporting framework.
- The Ministry will work with the other provinces and the Federal government in the development of a national monitoring and reporting system.

Appendix 2 Working Groups Membership

Drinking Water	Groundwater	Surface Water	Air Monitoring	Biomonitoring
K. Roberts (Chair)	K. Roberts (Chair)	F.Fleischer (Chair)	P.K. Misra (Chair)	D. Harper (Chair)
Hugh Graham	Sam Singer	Gary De Brou	Gary De Brou	Ron Pearson
Pat Lachmaniuk	Don Bartkiw	John Ralston	Bev Hanna Thorpe	Gary Westlake
Jim Smith	Ulu Sibul	Peter Dillon	Walter Chan	Ken Nicholls
Ron Hunsinger	John Miller	Wolf Scheider	Neville Reid	Keith Somers
Serge Villard	Phyllis Miller	Todd Howell	Dave Yap	Dennis Veal
Mel Plewes	Serge Villard	Doug Harper	Peter Wong	Dan Toner
Dale Henry	Brian Kaye	Serge Villard	Dan Toner	Dave Hollinger
Janusz Budziakowski	Jim Gehrels	Carol Sackville-Duyvelshoff	Dennis Corr	Ron Griffiths
Brian Howieson	Wanda Michalowicz	Phyllis Miller	Dennis Griffin	Allan Johnson
Bill Gregson		Stan Irwin		Peter Kauss
		Lloyd Logan		
		Art Roy		

Appendix 3 Generic Working Group Terms of Reference

Using the goals and objectives of monitoring and reporting as the focus, the program review process will assess existing EMRB monitoring programs and their tie-in with other ESSD/OD monitoring efforts, and determine/recommend future directions for monitoring in the province. This will be accomplished by:

- reviewing existing monitoring activities to identify current monitoring initiatives, client needs, data and reporting requirements.
- identifying monitoring gaps and needs, including resource impacts.
- providing options and giving recommendations for future monitoring directions, addressing the need for greater integration of monitoring efforts, data optimization, partnerships and effective reporting.

APPENDIX 4 **Working Group Questionnaire**

1994 MOEE MONITORING PROGRAM INVENTORY

Working Group: Air:___ Surface Water:___ Groundwater:____
Drinking Water:__ Biomonitoring:__

Program Name:_____
Contact:_____
Branch/Region/Section:_____
Start(Yr):_____ End(Yr):_____

Legal Instrument: Legislation:_____
Formal Agreement:_____
Guideline:_____
Policy:_____
Other:_____

Program Description:_____
_____
_____
_____

What is this program intended to determine?_____
_____
_____
_____

INDICATORS	Length of time monitored 1-4yr	4-10yr	10+yr	MEDIA

Spatial Focus: Local (name location)_____
Watershed (specify) _____
Regional (name location)_____
Provincial _____

Media sampled:
Water:_____ Drinking water:_____ Sediment:_____
Air: _____ Precipitation: _____ Indoor Air:____
Soil: _____ Waste: _____
Biol Material (specify_____

GIS Application: Are geographical units used? Yes___ No___
UTM:____ Lat/Long:___
Other (specify):_____

Client(s):	Use		Use
OCWA:	_____	Other Mins :	_____
Fed Govt:	_____	Other Provs:	_____
NGO's:	_____	Public:	_____
Academia:	_____	Consultants:	_____
Industry:	_____	Municipalities:	_____
ROD:	_____	Other:	_____

Appendix 4 (con't)

Partner(s):

	Role		Role
OCWA:	_____	Other Mins :	_____
Fed Govt:	_____	Other Provs:	_____
NGO's:	_____	Public:	_____
Academia:	_____	Consultants:	_____
Industry:	_____	Municipalities:	_____
ROD:	_____	Other:	_____

Partner(s):

Contribute financially: ____
In kind Contribution: ____
Amount: _____ Time frame:Yearly:____
Life of program: ____

Are you aware of other monitoring programs in the province similar to this one?
Yes:_____ No:_____

Name of program:_____
What organization coordinates this program?:_____

Annual Resources Allocation (MOEE): PY's: $_____
ODOE: $_____

Frequency of Reporting:

One time report:	___	Complaint:	___
More than one:	___	Regular/Continuous rpt:	___
No report:	___		

Storage and Retrieval:
Name of Database:_____

Where does the data reside?

Mainframe:	___	File-server:	___
Mini-computer:	___	SIS:	___
PC:	___	Hardcopy:	___

Other (specify):_____

In what application is the data manipulated?:

DBMS:

Oracle:	___	Informix:	___	Dbase 3/4:	___
Foxbase:	___	Clipper:	___	Q and A:	___
Paradox:	___	Focus:	___		

Other (specify):_____

SPREADSHEET:

Lotus:	___	Excel:	___	Qpro:	___

Other (specify):_____

TEXT:

Wordperfect: ___ Microsoft Word: ___
Other (specify):_____

Future program priorities:
What do you feel are the main gaps in monitoring efforts in the province?

Issue	Location (if applicable)
_____	_____
_____	_____
_____	_____

Appendix 5 Summary of Working Groups Questionnaires

Working Group	Program Name	Br.	Sect.	Intention	Length mon.	Media Sampled			GIS Appl.	Resources		Database Name	Data Resides		Data Manipulated		
										PY's	ODOE				dbms	Spr.Sht	Text
Air	Complaints,Special Studies	ROD	All	Adverse impacts on property, vegetation, soil and health	< 1 yr	Air	BiolM	Soil	UTM	13	$275,000	SIS/LIS, hard copy, etc.	MF	PC	N/A	N/A	WordP
Air	Mobile Tags	EMRB	SM	Mobile air surveys of Ind.Sources	10+ yrs	Air					185000		PC			Excel	WordP
Air	Air Quality monitoring	EMRB	AQM	State of air quality, AQI, and API	10+ yrs	Air			UTM/Lat/L			AQUIS	MF	Mini	JCL		
Air	Urban PAH	STB	AtmS	Levels of PAH at various urban sites	10+ yrs	Air			UTM			Urban PAH	PC		Clipper		
Air	Personal Exposure– Air Quality	STB	AtmS	Human risk to pollutants (chemicals)	1– 4 yrs	Many						Personal exposure	PC			Lotus	WordP
Air	Great Lakes toxics deposition	STB	AtmS	Concentrations of selected toxics in air and precipitation	10+ yrs	Air	Precip		UTM			Great L. Toxics Deposition	MF	PC	Clipper		WordP
Air	Acidic precip.in Ontario study	STB	AtmS	Determining spatial/temp. trends of air pollutants	10+ yrs	All			UTM/Lat/L			APIOS	MF	PC	Clipper		WordP
Air	VOC(Urban)	STB	AtmS	Typical lvels of VOC in urban areas of Ontario	4– 10 yrs	Air			UTM/Lat/L			Urban VOC	PC		Clipper		
Air	PCCD/PCDF	STB	AtmS	Ambient levels of PCDD/PCDF at a limited number of sites	4– 10 yrs	Air						PCCD/PCDF	PC		dBase3		
BioM	English/Wabigoon HG monitoring	ROD	North	Decline in HG levels, consumption advice to anglers	10+ yrs	BiolM			Lat/L			Sportfish Contaminant	PC		Oracle		
BioM	BioMap	ROD	SW	Ecological health of creeks	1– 4 yrs	BiolM			UTM	0.8							
BioM	Terrestr.Effects Assess.– Complaints	STB	PhytoS	Investigate/report emission impacts complaints on soil, etc.	10+ yrs	Soil	BiolM		UTM	2	$20,000		MF	PC		Lotus	WordP
BioM	Terrestr.Effects Assess.– Non Pt.Srce	STB	PhytoS	Trends in contamination of terrestrial receptors from air	10+ yrs	Soil	BiolM		UTM	2	$4,200	OTR	MF	PC		Lotus	WordP
BioM	In– situ fish bioassay program	STB	AqTox	Potential of discharges to produce env. effects on fishery	1– 4 yrs	Wtr	BiolM	Sed.	No	1.5	$5,000			HardC	Other	Lotus	WordP
BioM	Sportfish Contaminant Monitoring	EMRB	BioM	Protect the health of consumers of fish	10+ yrs	BiolM			Lat/L	2	$25,000		PC	HardC	dBase3		
BioM	Regional support(Pt.source mon.)	EMRB	BioM	Support ROD investigations re:health assess., biomon,etc.	10+ yrs	BiolM			Lat/L	2.75	$30,000		PC	HardC		Lotus	WordP
BioM	Support for RAPS	EMRB	BioM	Biomon. support before and after lake restoration projects	10+ yrs	BiolM			Lat/L	3.75	$45,000		PC	HardC		Lotus	WordP
BioM	Great Lakes intake monitoring	EMRB	BioM	Weekly mon. of intakes.Samples sedimented in BioM lab	10+ yrs	BiolM			Lat/L	1	$30,000		PC	HardC		Lotus	
BioM	RAPS program	PDB	PSS	To determine if delisting criteria have and will be met	10+ yrs	Wtr	Sed.	Soil	Lat/L		$84,900		MF	PC	Focus	Lotus	WordP
BioM	Terrestrial standars development	SDB	PhytoT	Establish typical background levels– In./Org. chems in soil	4– 10 yrs	BiolM	Soil		UTM	2.3	$40,000	OTR	MF	PC	dBase3	Lotus	WordP
BioM	Terrestr.effects assess.– point sources	SDB	PhytoT	Investigate soil/veg. contam.,emergenct response to spills	4– 10 yrs	BiolM	Soil		UTM	3.5	$57,000	SIS	MF	PC		Lotus	WordP
BioM.	Long– range transport– Biological	STB	AQSS	Assess goal of protection of lakes from airborne polls.	10+ yrs	Wtr			Lat/L	6	$95,000	DRC multiple databases	MF	Mini	Oracle	Lotus	WordP
BioM.	Muskoka Lakes Study	STB	AQSS	Health of lakes. Lake stresses and responses.	4– 10 yrs	Wtr	ShoreL		UTM/Lat/L	1.7	$40,000	DRC:Water Table Database	PC	Mini	Oracle	Lotus	WordP
BioM.	LSEMS Implementation Phase	STB	AQSS	Influences of Phosphorous on base of food chain	4– 10 yrs	Wtr	Sedim.		Lat/L	2.6	$140,000	LSEMS	MF	Mini	Oracle	Lotus	WordP
Dr.Water	Radiological data	STB		Emergency reference, trend information		Air	Dr.Wtr	Wtr									
Dr.Water	Specific contaminant response	STB	WWO	Assist in remediation of contaminants in Dr.wtr operations	4– 10yrs	Dr.Wtr			No	0.5	$10,000	None		HardC			
Dr.Water	Sewage/water inspection pgrm	ROD	All	Ensure performance, ensure DW at plants meets ODWO	4– 10yrs	Dr.Wtr			Not yet					HardC			
Dr.Water	Water plant intake monitoring	STB	AQSS	seasonal/long– term trends in ambient water quality	10+ yrs	Wtr			No	1	$25,000		PC		Focus	Lotus	
Dr.Water	WTP mon.where zebra mussels ctrls.	W.Plants		Effects of zebra mussel controls on THM formation	Various	Dr.Wtr			No	0	$0		HardC				
Dr.Water	Approvals of water works under OWRA	Appr.B		Ensuring WTP's satisfy current ODRO's to protect health	4– 10yrs	Dr.Wtr			No	3			HardC				
Dr.Water	Environmental Microbiology	Pub.labs		BActerial assessment of drinking water contamination	10+ yrs	Dr.Wtr	GW						HardC			Lotus	
Dr.Water	National Disifectant Byproduct survey	HealthC		Research into byproducts formed during chlorination	1 yr	Dr.Wtr							Unknown				
Dr.Water	DWSP	EMRB	DrW	Determine trends,protect human health,ID contaminants	4– 10yrs	Dr.Wtr			UTM	4	$175,000	DWSP	MF	PC	Focus		

Appendix 5 con't

Working Group	Program Name	Br.	Sect.	Intention	Length mon.	Media Sampled			GIS Appl.	Resources		Database Name	Data Resides		Data Manipulated		
										PY's	ODOE				dbms	Spr.Sht	Text
GroundW	Cof A Compliance Assessment	ROD	All	Assess compliance with concentration loads in CofAs	10+ yrs	Wtr	Dr.Wtr	Sed.				MIDES and TUMIS	MF	SIS			
GroundW	Domestic wells monitoring	ROD	SW	Impact of deep brine disposal practices on water wells	10+ yrs	GW				0.1			PC	HardC		Lotus	WordP
GroundW	Groundwater level surveillance	ROD	SW	Long-term GW level trends, monitoring specific problems	10+ yrs	GW			UTM	0.1	$2,000		PC		Other		
GroundW	Wellwater mon.- Bruce Nuclear	ROD	SW	Early detection - Impact on SW/GW from radioactive fallout	10+ yrs	Wtr	GW	DrW	No	0.1		BMPS - Wellwater					
GroundW	GW quality monitoring	ROD	SW	Produce GW quality maps for aquifers	10+ yrs	Dr.Wtr			UTM	0.2		GW quality data	PC	HardC		Lotus	
GroundW	Orphan site remediation	STB		Remediate contaminated soil,SW,GW- specific orphan sites	1- 4 yrs	All			UTM/Lat/L	2				HardC			
GroundW	Groundwater Quality Network	EMRB	DrW	Status of GW quality in province, trend information	10+ yrs	Wtr			UTM	2	$60,000	GW Quality IS	PServ	PC	dBase3		
GroundW	Closed waste sites	STB		Determine significant impacts -closed waste sites, remediate	1- 4 yrs	All			UTM/Lat/L	3				HardC			
GroundW	Private Services Subdivions reviews	ROD	All	Ensure sustainable development/wise use of GW resources	Once	Dr.Wtr	BioIM		Other	1.5		Hardcopy reports	HardC				
GroundW	Waste management reviews	ROD	All	Planning and mgmnt of waste management facilities	10+ yrs	GW			Other	10		Hardcopy reports	HardC				
GroundW	Environmental audits	ROD	All	Comparison purposes with environmental standards	Once	GW			Other			Hardcopy reports	HardC				
GroundW	Industrial site decommissioning	ROD	All	Comparisons to decommissioning guidelines	Once	GW			Other			Hardcopy reports	HardC				
GroundW	GW quality complaint investigations	ROD	All	Identify cause of quality problems/recommend solutions	Once	GW			Other	2			MF	SIS	HardC	Lotus	WordP
GroundW	GW quantity complaint investigations	ROD	All	Identify cause of quantity problems/recommend solutions	1- 4 yrs	GW			Other	2		Hardcopy reports	HardC				
GroundW	EPA part VIII approvals	ROD	All	Assess groundwater contamination		GW			Other			Hardcopy reports	HardC				
GroundW	Official plan reviews	ROD	All	Better use of available GW resources	Once	Wtr	Dr.Wtr		UTM			Hardcopy reports	HardC				
GroundW	Environmental Assessment reviews	ROD	All	Success of studies wrt the EAA	Once	GW			N/A			Hardcopy reports	HardC				
GroundW	Pit and quarry applications	ROD	All	ID and prevent potential GW interference problems	Various	GW			Other			Hardcopy reports	HardC				
GroundW	Regional well monitoring programs	ROD	All	Monitor general water quality and quantity	Ongoing	GW			UTM			PC					
GroundW	IEB Branch investigations	ROD	All	To determine if GW have or are likely to occur		GW			Other				SIS	HardC			WordP
GroundW	Misc.site monitoring	ROD	All	Health & safety/improve understanding of specific processes		All							SIS	HardC			WordP
GroundW	Sustainable soil productivity program	AGCan		Effect od zero till on root zone re; infiltration and leachate	Various												
GroundW	Water Well Information System	EMRB	Wtr	Compliance with Reg.903, assessment of GW use	10+ yrs	Wtr			UTM	3	$40,000	WWIS	MF	PC	Focus		
S. Wtr	Agricultural Pilot Watershed Study	STB	WMS	Long- term benefits of conservation farming practices	4- 10 yrs	Wtr	Precip.		UTM	0.2	$25,000	SIS	MF	SIS	Custom		
S. Wtr	Clean up Rural Beaches	STB	WMS	Long- term trends of program water quality changes	10+ yrs	Wtr			UTM	4	$6,000,000	LIMS	MF			Lotus	WordP
S. Wtr	Long- range transport-Chemical	STB	AQSS	Effects of long- range transport on the environment	10+ yrs	Wtr	Precip.		UTM/Lat/L	4.5	$300,000	Multiple	PC	Mini	Oracle	Lotus	WordP
S. Wtr	Mercury in the enviroment	STB	AQSS	Whether mercury in the enviroment is increasing	4- 10 yrs	Wtr	Precip.		UTM/Lat/L	1.5	$65,000	No name	PC		Oracle	Excel	MicroS
S. Wtr	Surface Water Modelling	STB	EMS	Impacts of chemical discharges or contaminants on media	10+ yrs	Wtr	BioIM		UTM/Lat/L	5	$50,000	None	PC	HardC	SPFPC	Lotus	WordP
S. Wtr	GrtLakes Screening Level Investig.	EMRB	SWS	To screen, measure impacts, & determine follow- up	10+ yrs	Wtr	BioIM	Sed.	Lat/L	3	$125,000	Under development	MF	PC	SAS	Lotus	WordP
S. Wtr	Great Lakes RAPS Support	EMRB	SWS	To ID conditions, measure impacts, & recommend actions	10+ yrs	Wtr	BioIM	Sed.	Lat/L	6.5	$281,000	Under development	MF	PC	SAS	Lotus	WordP
S. Wtr	Long- term Sensing Sites	EMRB	SWS	Provide trend info. on water/sediment quality in nearshore	1- 4 yrs	Wtr	BioIM	Dr.W	Lat/L	2	$165,000	No dedicated database	MF	PC	SAS	Lotus	WordP
S. Wtr	PWQMN- Fixed/Routine	EMRB	SWS	Long- term trends, to determine follow- up,ROD assess.	10+ yrs	Wtr	BioIM		UTM/Lat/L	2	$20,000	PWQMN	MF	PC			HardC
S. Wtr	PWQMN- Sediment	EMRB	SWS	Loadings of phosphorous, detections of industrial organics	10+ yrs	Wtr	Sed.		Lat/L	0.2	$40,000	PWQMN- BTMP	MF	SIS			
S. Wtr	PWQMN- Pesticides	EMRB	SWS	Incidence & frequency of pesticides, extent of loading.	10+ yrs	Wtr			Lat/L	0.2	$0	PWQMN- Pesticides	MF				
S. Wtr	Water Quantity Surveys	EMRB	SWS	Establish design flow criteria, complement quality studies	10+ yrs	Wtr			UTM/Lat/L	0.5	$200,000	DYDAT?CD- ROM	MF	PC			
S. Wtr	Recreational Lakes Program	ROD	East	Provides baseline data wrt lake development decisions		Wtr			UTM	1	$10,000	SIS	MF	SIS	dBase 3	Lotus	WordP
S. Wtr	APOIS - Lake sensitivity	ROD	North	Sensitivity of regional lakes to acid precip.(Ended 3 yrs ago)	4- 10 yrs	Wtr			Lat/L	1	$30,000		PC				
S. Wtr	Cottage self- help program	ROD	East	Trophic status of inland recreational lakes	10+ yrs	Wtr			UTM	0.5	$7,000		PC	HardC	dBase 3		WordP
S. Wtr	Spring Phosphorous	ROD	North	Carrying capacity of lakes for shoreline development	1- 4 yrs	Wtr			Lat/L	0.2	$1,500		PC		Other		WordP
S. Wtr	Sudbury extensive lakes	ROD	North	Relationship between sulfur emissions and water quality	10+ yrs	Wtr			Lat/L			SBS extensive	Mini			Lotus	
S. Wtr	Sudbury intensive lakes	ROD	North	Adequacy of controls re: aquatic protection and restoration	10+ yrs	Wtr	Sed.		Lat/L				PC			Lotus	
S. Wtr	Self- help program	ROD	North E	Trophic status of recreational lakes	10+ yrs	Wtr			UTM	0.8	$3,000	Self Help	PC			Lotus	WordP
S. Wtr	Spring Phosphorous	ROD	All	Lake shore development capacity		Wtr			UTM				MF	SIS		Lotus	WordP
S. Wtr	Waste assimilation studies	PDB		Short- tem studies of wtr downstream of polluting sources		Wtr	Sed.		No					HardC			
S. Wtr	Heritage Estate Stormwater	PDB	MS	Effectiveness of SW ponds, effect of heat shock	1- 4 yrs	St.W			No	0.6	$50,000		PC		Qbase	Lotus	WordP
S. Wtr	Rouge Watershed	SDB	WMS	Feasibility of developing wtrshed sediment screening criteria	1 yr	Sed.			Lat/L	1	$10,000		PC			Lotus	WordP

APPENDIX 6 (6a)

INVENTORY OF INTERNAL & EXTERNAL ENVIRONMENTAL DATA BASES
ENVIRONMENTAL REPORTING COORDINATION SECTION

November 23, 1994

MEDIA CLASS	PROJECT NAME	SUMMARY	PARAMETERS	Geog. Coverage	Length Record	Jurisdiction	Organization	CONTACT NAME	CONTACT PHONE #	KEYWORDS
AGR	AGRICULTURAL BENCHMARK SITES	Baseline data to assess soil quality changes	soil(permeability, density, compaction)	Ontario		Federal	Agr. Can	D. King	519 766-9180	
AGR	CENSUS AGRICULTURE	Data from operators of farms,ranches or other agr holdings	livestock,poultry,crops,fruits,veggies,value,expens	Ontario	> 10 yrs	Federal	SC	L. Kemp	613 951-8711	AGR,PEST,CROP
AGR	CENSUS OF WILDLIFE PELT PROD.	Data on wildlife pelts produced in Canada	type of wildlife pelts, value of production,kind	Ontario	> 10 yrs	Federal	SC	P. Mezaros	613 951-2505	PELTS,WDL
AGR	NATIONAL FARM SURVEY	Data on agricultural sector;based on farming operations	land use,operating arr.,livestock,farm expenses	Ontario	> 10 yrs	Federal	SC	P. Steven	613 951-2435	AGR,LIVESTOCK
AGR	ORGANIC MATTER	Organic matter in Ont.Topsoil inclu test/drain	% (sand,silt,clay), texture, drainage, pH	S. Ont	>10 yrs	Provincial	OMAF	B.van den Broe	519 767-3572	PDY,SOIL, GL
AGR	PESTICIDES USED IN ONTARIO	Temporal/spatial analyses of pesticides	pesticide(amt,use),etc	Ontario		Federal	EC/EHD	J. Struger		PEST,AGR, GL
AGR	SURVEY OF PESTICIDE USE	Estimates of pesticide use on crops, vegetables	quantity of pesticide/area sprayed	Ontario	4-10 yrs	Provincial	OMAF	B. McGee	416 326-3219	AGR, PEST, GL
AGR	SWEEP SURVEY	Document changes in tillage, conserv & cult.pract.	crops, fields, fertilizers,etc.	L.Erie Wat	1986&1991	Provincial	OMAF	P. Roberts	519 767-3578	AGR, GL
AGR	TILLAGE 2000 ECONOMICS	Field history, operation, yield for 34 farms	crop rotation, equip use, type fertilizer	C.E.N. Ont	4-10 yrs	Provincial	OMAF	D. Aspinall	519 767-3575	AGR,CROP, GL
AGR	TILLAGE 2000 GROWTH/YIELD	Crop growth, yields, moisture, population, pests, diseases	#plants, height, leaf counts	C.E.N. Ont	4-10 yrs	Provincial	OMAF	D. Aspinall	519 767-3575	AGR,CROP, GL
AGR	TILLAGE 2000 RESIDUE	Crop residue for 34 farms	% crop residue	C.E.N. Ont	4-10 yrs	Provincial	OMAF	D. Aspinall	519 767-3575	AGR,CROP, GL
AGR	TILLAGE 2000 SOIL	Detailed soil profiles	soil structure, root depth, pH, drainage	C.E.N. Ont	4-10 yrs	Provincial	OMAF	D. Aspinall	519 767-3575	AGR, SOIL, GL
AIR	ACID PRECIPITATION IN ONTARIO	Quantification of atmospheric loadings of acids	Precip(amt,metals,pH), air(SO2,metals)	Ontario	> 10yrs	Provincial	MOEE	D. Orr	416 323-5177	AP, CON, GL
AIR	AGRICULTURAL AGROCLIMATOLOGY	Climatic data examining shifts in climate patterns	air temp, soil temp, rel hum, wdir, wspd	S. Ont	>10 yrs	Provincial	OMAF	W. Roberts	519 767-3168	AGR,TECH,TOU
AIR	AIR POLLUTANTS COMPENDIUM	Info on air pollutants on economic sector & prov. basis	hydrocarbons,particulate,inorganics	Ontario	> 10yrs	Federal	EC/EPCP	T. Furmanczyk	819 994-3128	EMS,AQ,APOL,M
AIR	AIR QUALITY INFORMATION	Gaseous/particulate/meteorological data	gases, AQI, API, particulates, metals, wind	Ontario	> 10yrs	Provincial	MOEE	P.K. Mars	416 235-5766	AQ, CON, GL
AIR	CAN AIR & PRECIP MONITORING NETWO	Sampling air & precip,meter pans for acidifying air poll/ozone	chemicals, inorganics for air/precip	Ontario	< 10yrs	Federal	EC/MARD	M. Phillips	416-739-4449	AP,APOL,AQ,OZ
AIR	COMPLAINTS, SPECIAL STUDIES	Adverse impacts on property, veg, soil, & health	Vegetation, soil, health, property	Ontario	< 1yr	Provincial	MOEE	n/a	n/a	AIR,SOIL,HE
AIR	GREAT LAKES TOXIC DEPOSITION	To quantify atm loadings into Gr. Lakes	PCBs, PAHs,pesticides, metals,etc	Ontario	> 10yrs	Provincial	MOEE	M. Shackelton	416 323-5153	AQ, CON, GL
AIR	INTEGR. ATM. DEPOSITION NETWORK	Provide mass/balance toxics to Gr.Lakes	metals/trace organics in air/prec.	Gr. Lakes	< 3yrs	Federal	EC/AES	A. McMillan		ATM, PRECIP
AIR	MULTI-CITY ACID AEROSOL STUDY	Study on respiratory cond & air quality in Can & Ame cities	air & indoor env. quality, respiratory illness	Ontario	> 4 yrs	Federal	HWC	M Raizenne	613 957-1878	AP,AQ,HE
AIR	NATIONAL ATMOSPHERIC CHEMISTRY	Air and precipitation chemistry data	Prec:wet collectors,sampling,Air:filter,nylon,teflon,	Ontario	> 10 yrs	Federal	EC/AES	M. Phillips	416 739-4449	AP,AQ,PREC
AIR	NAT'L AIR POLLUTION SUR. NETWORK	Monitoring common Air contaminants	SO2,CO,O3,NO2,Pb,Nitrates,Sulphates	Ontario	> 10yrs	Federal	EC/EP	J. Shelton	613 991-9453	AQ,ENVM,POLL
AIR	ONTARIO EMISSION INVENTORY	Emission inventories of point/areas sources	SO2, NOx, CO, THC, part., toxics	Ontario	> 10yrs	Provincial	MOEE	P. Wong	416 235-6130	EMS,ENV SC,GL
AIR	ONT. HOSPITAL ADMISSIONS & AIR QUA	Daily #s of hosp admission/info on ambient air pollution	sulphates,nitrates,SO2,NO,ozone,respiratory illnes	Ontario	> 4yrs	Federal	HWC	R. Burnett	613 954-0170	AQ,HE,APOLL
AIR	PAHs MONITORING	Air data on PAHs in urban areas	33 selected PAHs	Ontario	4-10 yrs	Provincial	MOEE	G. Diamond	416 323-5212	CON,GL,TXCHE
AIR	PCDD/PCDF MONITORING	Air data for PCDD/PCDF	toxic congeners	Ontario	4-10 yrs	Provincial	MOEE	P. Steer	416 323-5091	AQ, CON, GL
AIR	RADIATION PROTECTION	Measurement of radiation source	X-ray inventory, #rad sources	Ontario	n/a	Provincial	MOL	J. Barry	416 326-7133	RADN,HHE,GL
AIR	RESIDUAL DISCHARGE INVENTORY SYS.	Dbase of emission estimates for pollutants from other source	SO2,NO,CO,HC,NH3,particulate matter,VOC	Ontario	> 10 yrs	Federal	EC/PDAD	M. Desleuriers	819 994-3069	EMS,IND,MV,
AIR	VOLATILE ORGANIC COMPOUNDS	Quantify VOCs in urban areas	36 VOC compounds	Ontario	4-10 yrs	Provincial	MOEE	P. Steer	416 3235091	AQ, CON, GL
AVIATION	ENVIRONMENTAL SCREENING SYSTEM	Consultative sys of environmental information for Can airport	terrestrial & aquatic animals,habitat,soil,atmosph	Ontario	> 10 yrs	Federal	TC	A. Simpson	613 990-0512	ENV.ASSESS
AVIATION	ENV. ASSESSMENT & REVIEW PROCESS	Environmental screening decisions for all Airport Grp. Proj.	record,project number,airport,fiscal year,descripti	Ontario	> 10 yrs	Federal	TC	R. O'Brien	613 990-1402	ENV.ASSESS
BIOM	AQUATIC INVERTEBRATE	Aquatic habitat inventory in streams/rivers	invertebrates, chemical, physical, biol.	Ontario	> 10yrs	Provincial	MNR	G. Gale	416 314-1320	RIV,WDL,INSECT
BIOM	ATLAS OF COLONIAL WATERBIRDS	Waterbirds nesting on the Gr. Lakes	species, number colonies,etc	Gr. Lakes	4-10 yrs	Federal	CWS	H.Blokpoel		WBRDS, GL
BIOM	ATLAS (SPECIES NAME) LAKES	Lake listings of fish(walleye,lake trout,bass,pike)	fish species, lake char, survey status	Ontario	4-10 yrs	Provincial	MNR	F. McNeil	905 832-7292	BIO,FSH, GL
BIOM	AVIAN PRODUCTION AND SURVIVORSHI	Info on breeding birds in woodlands	demographic/population info.	Ontario	4-10 yrs	Federal	CWS		819 997-4213	BRDS,SPC,WDL
BIOM	AVIAN USE OF AGROHABITATS	Birds species comp. of habitats in agr. landscapes in GL.	birds species, species activities,habitat des.	GL, S. Ont.	> 10yrs	Federal	EC/MBSD	K. Freeman	819 997-6082	BIO,BRDS,HAB
BIOM	BIOLOGICAL/CONSERV. SYSTEM.	Databases on rare plants/animals,plant commun.	plant/animal spcies, plant commun.	Ontario	4-10 yrs	Provincial	MNR	I. Kirkham	705 745-8307	ENDSP,WDL,GL

APPENDIX 6 (file)

INVENTORY OF INTERNAL & EXTERNAL ENVIRONMENTAL DATA BASES
ENVIRONMENTAL REPORTING COORDINATION SECTION

November 23, 1994

MEDIA CLASS	PROJECT NAME	SUMMARY	PARAMETERS	Geog. Coverage	Length of Record	Jurisdiction	Organization	CONTACT NAME	CONTACT PHONE	KEYWORDS
BIOM	BIRD BANDING & REC. DATABASE	Bird banding & bird recovery across Canada & USA	birds species,attributes, banding,recovery	Ontario	> 10yrs	Federal	EC/MBSD	E. Hayshaw	519 953-1428	BIO,BRDS,WDL
BIOM	BLACK BEAR RESEARCH	Studying habitat types for harvest determination	Pop., harvest, habitat, food avail	N. Ont	> 10 yrs	Provincial	MNR	M. Obard	905 833-7132	HAB,WDL,GL
BIOM	BLACK DUCK SURVEY	Breeding population of black duck	numbers,etc	Ontario		Federal	CWS			BLKDCK
BIOM	BREEDING BIRD SURVEY	Determine changes in breeding bird population	roadside habitats	Ontario	> 10 yrs	Federal	CWS	M. Cadman	519 766-1606	BRDS, HAB
BIOM	BUTTERFLIES OF ONTARIO	Butterflies and summaries of Lepidopters		Ontario		Local	Local Club	Tor.Entomolog.		BUTTERFLIES
BIOM	CANADIAN ZOOPLANKTON DATABASE	Dist & abund of zooplankton,water chem for Canadian Lakes	climate, water temp,chem.plankton,growing season	Lakes	> 10 yrs	Federal	DFO	K. Patalas		BIO,ZPLANKTON
BIOM	CHRISTMAS BIRD COUNT	Monitor changes in dist. of wintering birds	# of each species,# observers,etc.	Ontario	> 10yrs	Local	Local Club			WINTER BRDS
BIOM	CONTAMINANT SURVEILLANCE	Contaminant trends in fish comm. and forage bass	species(age,sex,size), metals	Gr. Lakes	> 10yrs	Federal	DFO	D. Whittle	416 336-4565	BIO,GL,FSH
BIOM	CONTAMINANTS IN FISH DATABASE	Past & heavy metal con'c in comm fish species in Great Lakes etc	fish species,contaminants(PCB,pesticides),data	Lakes	> 10 yrs	Federal	DFO	M. Handel	204 983-5057	CON,BIO,FISH
BIOM	DEER WINTER FEEDING	Diet/methods used to feed deer in emerg.	feeding types, behaviour, technique	Ontario	4-10 yrs	Provincial	MNR	D. Voight	905 832-7347	MAMM,WDL,GL
BIOM	DENDROCHONOLOGY STUDY	Tree growth charact. for sugar maple/red pine	tree/soil characteristics	S.& C. Ont	4-10 yrs	Provincial	MOEE	R. Pearson	416 323-6102	BOT, TREE, GL
BIOM	DFO CENTRAL & ARCTIC REG. FISHERY	FFMC/DFCO dbase comm fish harvest for transections	recreational fisheries,marine mammals,licences	Ontario	> 10 yrs	Federal	DFO	P. Thompson	204 983-5227	BIO,ARTIC,FISH
BIOM	FIELD CROP OXIDANT INJURY	Assess ozone acute toxicity to tomato,potato,bean	rooted toxicity symptoms, cultivar	S. Ont	n/a	Provincial	MOEE	R. Pearson	416 323-6102	
BIOM	FISH COMMUNITY SYNTHESIS	Summarized data on lake trout fish communities	catch stats, population attributes,etc	Ontario	> 10 yrs	Provincial	MNR	R. Kerver	905 833-7130	FSH,WDL,GL
BIOM	FISH POPULATION ANALYSIS	Summary database of fish species/group	stream assess/productivity, fish species	Ontario	4-10yrs	Provincial	MNR	Senior Planner	416 314-1320	BIO,FSH,GL
BIOM	FISH SPECIES DISTRIBUTION	Province-wide fish species distribution	fish, species, rare/endangered	Ontario	> 10yrs	Provincial	MNR	G. Gale	416 314-1320	FSH,WBDS,WDL
BIOM	FISH STOCKING	Support policy/partnership Gr. Lakes Commis	fish species, age, size, dev.stage,etc	Ontario	> 10yrs	Provincial	MNR	P. Hutcheon	705 740-1831	FSH,WDL,GL
BIOM	FOREST BIRD MONITORING	Population changes/species habitat of forest birds	bird species,habitat types	Ontario	4-10 yrs	Federal	CWS	M. Cadman	519 766-1604	BIO,BRDS,FOR
BIOM	FRESHWATER PLANKTONIC INVER. DBASE	Bibliography on freshwater planktonic invertebrates	biochem,ecology,fisheries,pathology,bibliography	Ontario	> 10 yrs	Federal	CMN	R. Changsleth	613 954-4956	AECO,BIO,WA
BIOM	GENERAL INVERTEBRATES DBASE	Data on gen. invertebrates Can Museum of Nature collection	taxonomy,geo info,habitat,preservation & conservation	Ontario	> 10 yrs	Federal	CMN	R. Changsleth	613 954-4956	BIO,INVER
BIOM	GREAT LAKES BIOLOGICCAL TISSUE	Data on analyses/storage of fish specimens	Specimen(age,wt,sex,lgth),quantity)	Gr. Lakes	> 10yrs	Federal	DFO	W. Hyatt	416 336-4661	BIO,GL,FSH,TISS
BIOM	GREAT LAKES CON SURVEILLANCE PROG.	Contaminant levels in fish from Canadian Great Lakes	fish collection date,species,size,trace org.metals	Gr. Lakes	> 10 yrs	Federal	DFO	D. Whittle	416 336-4565	BIO,CON,GL
BIOM	GR.LAKES BIOLOGICAL TISSUE ARCHIVE	Analyses & storage of fish specimens from Canadian Gr.Lakes	quantity of material,storage history,location,date	Gr. Lakes	> 10 yrs	Federal	DFO	W. Hyatt	416 336-4661	BIO,CON,GL
BIOM	HAWKWATCHING	Population trend of diurnal raptors	# birds at migration pts.	localized		Local	Local Club	Various	519 434-8884	HAWKS, MIGR,
BIOM	HAZARDOUS WASTES INVENTORY	Monitor transfer hazardous/liquid ind. wastes	co.(name,loc), waste(type,quant)	Ontario	4-10 yrs	Provincial	MOEE	W. Tao	416 314-7864	WSTE,CON, GL
BIOM	HERPETOLOGY	Records of preserved specimens and frozen tissues	species(name,locality,habitat),etc	Ontario	> 10yrs	Provincial	ROM	R. Murphy	416 586-5750	BIO,REPT,GL
BIOM	HISTORICAL FOLIAR SULPHUR	Red/white pine,aspen/paper birch foliage	species, foliar chemistry	Sudbury	n/a	Provincial	MOEE	R. Pearson	416 323-6102	AP, BOT, GL
BIOM	ICHTHYOLOGY	Fish records in ichthyology collection	Species(location,habitat), taxonomy	Ontario	> 10yrs	Provincial	ROM	E. Holm	416 586-5780	BIO,FSH,GL
BIOM	IMPORTANCE OF WILDLIFE TO CANADIANS	Data from Can. on their wildlife activities & expenditures	wildlife act.attitude,type,grps,personal info (age	Ontario	4-10 yrs	Federal	EC/CWS	A. Helming	613 951-4662	WLD,BOR WATCH
BIOM	LAKE ERIE BIOMONITORING	Effect of zebra mussel and reduced nutrient loading	nutrients, biomass, chlorophyll	L.Erie	<3 yrs	Federal	DFO	O.Johnnason	905 336-4706	ECOSY,BIO,BED
BIOM	LAKE ONT. BIOLOGICAL MONITORING.	Trend in physical cond., nutrients, commun. structure	physical, chemical, nutrients	L. Ont	> 10yrs	Federal	DFO	O.Johnnason	905 336-4706	ECOSY, GL
BIOM	LICHEN AND MOSS CHEMISTRY	Lichen/Moss chemistry data	lichen/moss species, metals	Ontario	< 3yrs	Provincial	MOEE	R. Pearson	416 323-6102	BOT,PLANTS, GL
BIOM	LRTAP BIOMONITORING SITES	Info waterfowl prod. water chem, fish status,morpho data	bio6c:fish status,den, aqua:pH,ions,Org Ca	Ontario	> 10yrs	Federal	EC/CWS	D. McNeil	613 952-2409	AP,GIS,HAB,WDL
BIOM	MAMMALOGY	Mammal specimen records	species(location,breeding), habitat	Ontario	> 10yrs	Provincial	ROM		416 586-5798	BIO,MAMM,GL
BIOM	MARCH BIRD MONITORING	Population trends/habitats marsh-nesting species	species	Gr. Lakes	< 3yrs	Federal	CWS	M. Cadman	519 766-1604	BIO, BRDS,MARSH
BIOM	MAY BREEDING POP SFC WATERFOWL	Estimates of breeding waterfowl by species & strata	ponds,# wetowl by species,#counts,#Ca G	Ontario	> 10yrs	Federal	EC/CWS	D. Caswell	204 983-5280	BIO,WLD,MBRDS
BIOM	MIGRATION MONITORY	Long term population monitoring	# birds at migration points	localized	> 10yrs	Local	Long Pt Club	J. McCracken	519 586-3531	BRDS,MIGR,
BIOM	MIGRATORY BIRD HARVEST	Sampling hunter kills to determine limits	sex, age, species	Ontario		Federal	CWS			MBRDS
BIOM	MIGRATORY GAME BIRD POP STATUS	Pop size/habitats cond of waterfowls across N. America	pop species in various seasons, pond counts	Ontario	> 10yrs	Federal	EC/CWS	K. Dickson	519 9531415	BIO,MBRDS,WDL
BIOM	NATIONAL HARVEST SURVEY	Info on hunter activity & migratory game bird kill	Fed. migratory bird kill (species,age,sex), activity	Ontario	> 10yrs	Federal	EC/CWS	E. Hayshaw	519 953-1428	BIO,BRDS,MBRDS
BIOM	NAT'L REGISTRY OF TOXIC CHEM. RES	Toxics chemical levels in bird,mammal,reptile & amphibians	species,dioxin,organochlo,PCBs,pest,Hg,trace	Ontario	> 10yrs	Federal	EC/CWS	B. Wakeford	519 987-1412	BIO,CON,WLD
BIOM	NORTHERN ONTARIO WATERFOWL DBASE	Info on waterfowl population,species,habitat preference	species,sex,density,wetland habitat type	Ontario	> 10 yrs	Federal	EC/CWS	K. Rees	613 952-2415	BIO,BRDS,GIS,HAB
BIOM	ONTARIO BIRDS AT RISK	Monitor vulnerable, threatened, scarce birds	red-should.hawk,loggerhead shrike	Ontario	< 3yrs	Local	Long Pt Club		519 586-3531	BRDS,ENDSP
BIOM	ONTARIO FOREST BIRD MONITORING PROG.	Bird species & abund for major forest type thruout ONT.	birds and trees species, abundance, density,veg.	Ontario	> 10 yrs	Federal	EC/CWS	D. Welsh	613 952-2405	BIO,FOR,WLD,
BIOM	ONTARIO HERONRY INVENTORY	Information on the heron bird colony	colonies (size/number)	S. & E. Ont	4-10yrs	Local	Long Pt Club			HERONS

APPENDIX 6 (6c)

INVENTORY OF INTERNAL & EXTERNAL ENVIRONMENTAL DATA BASES
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November 23, 1994

MEDIA CLASS	PROJECT NAME	SUMMARY	PARAMETERS	Geog. Coverage	Length of Record	Jurisdiction	Organization	CONTACT NAME	CONTACT PHONE #	KEYWORDS
BIOM	ONTARIO NEST RECORDS SCHEME	Data on nesting biology of Ontario birds	breeding success, dist., habitat	Ontario	> 10yrs	Fed/Prov	ROM	G. Peck	416 586-5519	
BIOM	ONTARIO TYPICAL RANGE	Background soil/veg data	metals, PAHs, PCBs, dioxins/furans,pH	Ontario	4-10yrs	Provincial	MOEE	R. Pearson	416 314-5102	BOT,PLANTS, GL
BIOM	ORNITHOLOGY	Data for all ornithology collections	skins, skeletons, nests, eggs,etc	Ontario	> 10yrs	Provincial	ROM	B. Millen	416 586-5523	BIO,BRDS,GL
BIOM	PHYTOPLANKTON DYN. IN GREAT LAKES	Data on phytoplankton dynamics in Great Lakes	biomass,size comp,productivity,chlorophyll,species	Gr. Lakes	> 10 yrs	Federal	DFO	M. Munawar	416 336-4867	GL,AECO,BIO
BIOM	POLAR BEAR RESEARCH	Tracking background info on polar bears	polar bear size/movement, reprod.	Hud/James B.	> 10yrs	Provincial	MNR	M. Obard	905 832-7132	MAMM,WDL
BIOM	SOIL BASELINE CHEMISTRY	Baseline soil data to assess acidic precip.	texture, pH, total N, metals,etc	Ontario	4-10yrs	Provincial	MOEE	R. Pearson	416 323-5102	CON,SOIL,GL
BIOM	SOUTHERN ONTARIO GEESE	Annual density/productivity studies Ontario geese	number, reproduction,etc	Ontario		Federal	CWS			GESE,S.ONT
BIOM	SPORT FISH CONTAMINANT	Results from sport fish sampling	species(length,wt,ht), Hg, PCBs,etc	Ontario	> 10yrs	Provincial	MOEE	C. Cox	416 314-7901	CON, FISH, GL
BIOM	SPRING BREEDING WATERFOWL SURVEY	Population data for waterfowl from E. Canada,US	waterfowl species,bird sex, # of birds	Ontario	> 10 yrs	Federal	EC/CWS	K. Dickson	819 953-1415	BIO,BRDS,WDL
BIOM	SURVEY OF SPORT FISHING DBASE	National dbase on angling in each jurisdiction/socio-eco info.	anglers,harvest,consumption fish,personal assessm	Ontario	> 10 yrs	Federal	DFO	K. Brickley	613-993-2284	FISH,ANGLERS
BIOM	THREATENED AND ENDANGERED SPECIE	Info on distribution,sources for endangered species	species name,status,dis,source,habitat,activity	Ontario	> 10 yrs	Federal	EC/CWS	K. Lloyd	819 997-6073	BIO,ENDSP,GIS
BIOM	TORONTO LEAD SURVEY	Assess lead levels in veg./soil for trans. corridor	lead + metals, shrub foliage, soil	Metro Tor.	> 10yrs	Provincial	MOEE	R. Pearson	416 323-5102	CON,SOIL, GL
BIOM	TOXICS IN TERRESTRIAL ENVIRONMENT.	Background chemistry for urban/rural soils	PAHs, PCBs, dioxin/furans, DDT,etc	S. Ont	< 3yrs	Provincial	MOEE	R. Pearson	416 323-5102	CON,SOIL, GL
BIOM	TREE SEEDLING PLOT	Monitor response of tree seedling to acidic precip.	tree(crown,diameter),foliage, soil	NE. Ont	> 10yrs	Provincial	MOEE	R. Pearson	416 323-5102	AP, BOT, GL
BIOM	VEG. BASELINE FOLIAR CHEM.	Foliar chemistry of tree species for acidic precip.	tree species, metals	S. Ont	> 10yrs	Provincial	MOEE	R. Pearson	416 323-5102	AP, BOT, GL
BIOM	WILDLDIFE INFORMATION	Inventory of wildlife	life history, habitat, food,etc	Ontario	> 10yrs	Provincial	MNR	F. McKay	416 314-1041	ECO, MAMM,GL
BIOM	WILDLIFE HEALTH RESEARCH	Data on parsastes/toxins in wildlife	moose, ticks, mink/wolf parasites,etc	Ontario	> 10yrs	Provincial	MNR	E. Addison	416 832-7106	HE,WDL,GL
BIOM	YOUNG OF YEAR (FORAGE) FISH	Monitor non-migratory fish for source of discharges of con.	chemical, PCBs,DDT, metabolites	Ontario	> 10yrs	Provincial	MOEE	K. Buns	416 235-5798	CON, FISH
CHEM	CAN COUNCIL OF MOE PCB INVENTORY.	Inventory,uses of PCBs, info on askarel,con. m.oil/equip	PCBs type,con'c,capacity,# of units,Manu serial #	Ontario	> 5 yrs	Federal	EC/WMB	J.Stevenson	819 994-0569	CON,PCB,WSTS
CHEM	CHEMICAL PROFILES DATABASE	Database over 900 pure chem under Trans of Dangerous Good	chemicals, physical,toxicity,hazard rank,abstract	Ontario	< 4yrs	Federal	EC/WMB	L. Trip	819 953-3415	CHEM,TRANS,TO
CHEM	DOMESTIC SUBSTANCES LIST	List of Chem substances imported/manufactured in Canada	substance name,uses,amount,srts of manu	Ontario	> 10 yrs	Federal	EC/NSD	Division Chief	819 997-4336	CHEM
CHEM	FERROUS FOUNDRY DATABASE	Database on prod facilities & poll control of Ferrous Foundries	co. name,indus,cat,capacity,send use,additives,poll	Ontario	> 10yrs	Federal	EC/MMMPD	B. Blakeman	819 953-1105	FF,MNG,IND
CHEM	INVEN. OF CAN NON-FERROUS FOUNDRIE	A national dbase on prod. facilities of non-ferrous foundries	metals used,prod,non-ferrous alloy,moulding/meltin	Ontario	> 10yrs	Federal	EC/MMMPD	B. Blakeman	819 953-1105	POLL,IND,METAL
CHEM	LEAD ADDITIVES IN GASOLINE	Quan & Conc of lead additives in gasoline imp & pro in CA	quant and conc of lead added to gasoline	Ontario	> 10yrs	Federal	EC/CCB	P. Harris	819 953-1673	CON,HC,OIL,GAS
CHEM	MINE COMPLIANCE DATA	Database on Liquid Eff. for Base metal,iron ore,ur,gold,Ag	mine,minerals ore,cyanide rem,eff con, pH,	Ontario	> 1yr	Federal	EC/MMMPD	B. Wong	819 997-2294	EFF,IND,POLL
CHEM	MISA -IRON & STEEL INDUSTRY	Info on pollutants in liquid eff from Iron & Steel Industry	solid,N2 cpds, Cyanide,trace/heavy metals	Ontario	> 10 yrs	Federal	EC/MMMPD	K. Mah	819 997-2271	EFF,IND,MNG
CHEM	NON-FERROUS SMELTERS DATABASE	Non-ferrous,basemetal smelters,air emiss,poll control methods	emiss parameters,SO2,particulates,metal,by-produc	Ontario	> 10yrs	Federal	EC/MMMPD	J. Mecletchy	819 953-1605	EMS,MNG,IND
CHEM	NUCLEAR DATA SYSTEM	Registry of con. in effluents assoc. with Uranium Mng/milling	pH,radionuclides,alkanity,dissolved solids	Ontario	> 10 yrs	Federal	EC/EP	P. Vasudev	819 953-1127	EFF,MNG,IND,W
CHEM	OZONE DEPLETING SUBTANCES:TRADE	Industry to provide the trade & use of ozone depleting subs.	name of substance, prod, import & export of subs	Ontario	> 10 yrs	Federal	EC/CCB	Y. Bovet	819 953-1668	OZ,CFCs,HCFC
CHEM	PESTICIDE REGISTRANT SURVEY	Sales data of pest. by ingredient,prov,pattern,info on pest etc.	pesticide type,ingredient,prod,registration#,market	Ontario	> 10 yrs	Federal	EC/CCB	T. Brien	819 953-1669	AGR,CON,FOR
CHEM	RESTRICTED INFO SYS FOR CHEMICALS	Inventory of PCB in use or in storage in ONT.	PCB type,use, location, equipment,co. name	Ontario	> 10 yrs	Federal	EC/EP	M. Vanderhaen	416 973-1080	CON,PCB,WSTS
CHEM	SULPHUR CONTENT IN LIQUID FUELS	Info on the content of sulphur in liquid fuels.	Sulphur conc,fuel,amount of fuel produced,produc	Ontario	> 10 yrs	Federal	EC/OGED	B. Made	819 953-1136	CON,OIL,FUEL
CLIMATE	METEOROLOGICAL DATA SYSTEM	Data on wind speed,dir,air/water temp, relative humidity	Wind speed,dir;air/water temp;rel hum	Ontario	> 10yrs	Federal	EC/CCIW	J. Bull	416 336-4634	CLI,TEMP,HUM
CLIMATE	NATIONAL ARCHIVE(CLIMATE)	Monitoring meteorological parameters	cli,evap,ozone,radiation,precip,satellite,snow	Ontario	> 10yrs	Federal	EC/CCC	M. Webb	416 739-4335	CLI,PREC, TEMP
DR WATER	DRINKING WATER SURVEILLANCE PROG.	Water quality/treatment database for dr. water sys.	micro,chemical,radionuclides	Ontario	4-10 yrs	Provincial	MOEE	H. Graham	416 314-4164	HHE,WATER,GL
DR WATER	ENVIRONMENTAL BACTERIOLOGY	Compliance monitoring for bacteria	coliform Dr.water, escherichia coli	Ontario	4-10 yrs	Provincial	MOH	M. Brodsky	416 235-5917	BIO,HHE, GL
DR WATER	UTILITY MONITORING INFORMATION.	Effluent data from sewage/dinnking water plants	ind.sector, non/conventional parm.	Ontario	> 10yrs	Provincial	MOEE	K. Sharma	416 314-7905	CON, EFF, GL

APPENDIX 6 (6d)

INVENTORY OF INTERNAL & EXTERNAL ENVIRONMENTAL DATA BASES
ENVIRONMENTAL REPORTING COORDINATION SECTION

November 23, 1994

MEDIA CLASS	PROJECT NAME	SUMMARY	PARAMETERS	Geog. Coverage	Length Record	Jurisdiction	Organization	CONTACT NAME	CONTACT PHONE #	KEYWORDS
FORESTRY	ANNUAL CENSUS OF FORESTRY	Information on operation of the forestry industry	business,inventories,revenue,exports,outputs	Ontario	> 10 yrs	Federal	SC	J. Lepage	613 951-3516	FOR,LOGGING
FORESTRY	FOREST RESOURCE INVENTORY	State of forestry resource	forest type, wood volume, age, class	Ontario	> 10yrs	Provincial	MNR	data admin	705 945-6757	FOR,TREE,GL
FORESTRY	FOREST RESOURCES INVENTORY	Inventory of forested lands	forest stand, age, specie, ht,etc	Ontario	> 10yrs	Provincial	MNR		705 945-6757	FOR,TREE,GL
FORESTRY	HISTORICAL FOREST STAND MAPS	Analysis of temporal changes in forest	forest stand type/species	Ontario	4-10 yrs	Provincial	MNR	Data Admin	705 945-6757	FOR,TREE,GL
FORESTRY	LARGE SCALE PHOTOGRAPHY	Photos to document forest structure charact.	forest(tree specie, height, vol.wood,etc)	N. Ont	4-10 yrs	Provincial	MNR	F. Addante	705 945-6879	RMS,TREE,GL
FORESTRY	THEMATIC MAPPING	Inventory of natural resource entities maps	land/forest cover, soils, terrain,etc	localized	> 10yrs	Provincial	MNR		416 314-1323	GIS,RMS,GL
GR WATER	GIS DIGITAL MAP COVERAGE	Base maps covering soil, physiography, land use	climate, soil type, landuse, gr.water	S. Ont	4-10 yrs	Provincial	OMAF	B. van den Broek	519 767-3525	ENVSC,GIS,GL
GR WATER	GROUND WATER QUALITY MONITORING	Produce Ground Water quality maps for aquifers	overburden/bedrock aquifers, qual. maps	Ontario	> 10yrs	Provincial	MOEE	S. ESSOP	n/a	GR> WATER,WQ,
GR WATER	GROUND WATER QUALITY NETWORK	Network/Status of wells, groundwater in the province.	Micro,chemistry,metal, pesticide	Ontario	> 10yrs	Provincial	MOEE	K. Roberts	416 235-6250	WQ,CON,WATER
GR WATER	REGIONAL WELL MONITORING PROG.	Monitor general water quality and quantity	Chemistry, biological	Ontario	ongoing	Provincial	MOEE	n/a	n/a	WQ,CON,WATER
GR WATER	WELL WATER INFORMATION	Water well record summaries	water well(depth,casing type,use,etc)	Ontario	> 10yrs	Provincial	MOEE	K. Yee	416 314-4156	HYD,WATER, GL
HEALTH	CANADIAN MORTALITY DATA BASE	Automated medical follow-up facilities/statistical info on health	personal information,death details,geo. variables	Ontario	> 10 yrs	Federal	SC	M. Fair	613 951-1734	DIS,HE
HEALTH	GENERAL SOCIAL SURVEY -CYCLE1	Data on disability, health and Lifestyle	lifestyle,health prob, support network,services	Ontario	> 10 yrs	Federal	SC	E. Prought	613-951-9180	SOCIAL,HE
HEALTH	HOSPITAL MORBIDITY	Info in diseases &surgical procedures of persons in hospitals	hospital sep,surgical pro,age,sex,diagnosis,prov.	Ontario	> 10 yrs	Federal	SC	R. Laflemme	613 951-1839	HE,HOSP
HEALTH	NATIONAL CANCER INCIDENCE REP.SYS	Cancer incidence by type of cancer, incl: geo,demog,per info	age,sex,residence,birth,death,source of registration	Ontario	> 10 yrs	Federal	SC	N. Hault	613 951-1746	DIS,HE,CA
HEALTH	NAT'L ANALYSIS OF TRENDS IN EMERG SY	Inven. of accidents involving spills of hazardous material	amt,loc,site type,cause,reason,sector,cleanup	Ontario	> 10 yrs	Federal	EC/EE	G. Cloutier	819 953-6874	OIL SPILLS,HMA
INDUSTRIAL	ENVIRONMENTAL INFORMATION SYSTEM	Info & statistics on analysis & assessment of state of Env.	biophysical cond,crop type, pest used,dwellings,	Ontario	> 10 yrs	Federal	SC	P. Fong	613 951-5838	AGR,GIS,IND
INDUSTRIAL	ANNUAL SURVEY OF MANUFACTURES	Information on the operations of manufacturing sector	operating statics,shipments,inventories,labour data	Ontario	> 10 yrs	Federal	SC	C. Hebert	613 951-3534	IND,MANU
INDUSTRIAL	CRUDE PETRO & NATURAL GAS PRO.	Survey on prod,final destination of crude oil,natural gas:	gross production crude oil,plant,field use,inventories	Ontario	> 10 yrs	Federal	SC	G. Smallridge	613 951-3567	HC,OIL,EXT
INDUSTRIAL	ELECTRICITY SUPPLY/DISPOSITION	Data on supply & disposition of electricity in Canada	energy generated, used,trans,value of elec energy	Ontario	> 10 yrs	Federal	SC	D. Madsen	613 951-3585	ELEC,ENERGY
LAND	CANADA GL COASTAL ZONE DATABASE	Info on shoreline land use,str,flood,erosion hazard areas	land use,erosion/flood data,location wetlands	GL-St.Lawr R.	> 10yrs	Federal	EC/WPMB	W. Glen	416 336-4948	GL,ESA,ERO,GIS
LAND	CANADA GEOGRAHIC INFORMATION SYS.	Database for Canada Land Inventory;agr,for,rec,wildlife,eco	land class,cover,activity,limitation	Ontario	> 10yrs	Federal	EC/EIBD	E. Beaudette	819 953-1467	AGR,FOR,LAND,
LAND	CANADIAN PARKS SERVICE INVENTORY.	Geo. & biophy data on national parks,soil,veg,forest	soils, vegetation,hydrology,geo features,wildlife	Ontario	> 10yrs	Federal	EC/NRB	N. Samain	819 994-5523	GIS,HYD,WLD,NP
LAND	CROWN LAND SURVEY	Parks/land deposition records	surveys, plans, field notes	Ontario	>10 yrs	Provincial	MNR	G. Sherman	416 314-1285	GEO, LAND,GL
LAND	LAKE SUPERIOR SHORE	Data on flood/erosion from survey of Ca Lake Sup shoreline	structure type/qual,elev,res/seas status,pro photo	Ontario	< 1yr	Federal	EC/CCIW	W. Glen	416 336-4948	ERO,FLD,GL,ONT
LAND	LAND INDEX SYSTEM	Record of Crown land status	land(status,disposition,grant)	Ontario	> 10yrs	Provincial	MNR	G. Sherman	416 314-1384	GEO, LAND, GL
LAND	LAND INVENTORY	Maps showing land use capability	land class, timber/recreational use	Ontario	> 10yrs	Provincial	MNR	T. Ellis	416 314-1319	GEO, LAND, GL
LAND	PARK USE RELATED DATA SYSTEM	Info on the use of historic sites,canals,parks and sites.	entrees, visits, vehicles,persons, entries	Ontario	> 10 yrs	Federal	EC/SEB	J. Beaman	819 997-6305	LAND,PARKS
SFC WATER	ACID RAIN AGGRE. CHEMICAL DATA	Trace mets and major ion data for lakes in E. Canada	major ions,metals,pH,alkalinity,lake area	Ont., Que,Atl.	< 10yrs	Federal	EC/RRB	D. Jeffries	416 336-4969	AP,WQ,LAKES
SFC WATER	APIOS -LAKE SENSITIVITY	Sensitivity of region lakes to acid precip (ended 3yrs ago)	Water chemistry, acid precip	Ontario	4-10yrs	Provincial	MOEE	A. Hollinger	n/a	AP, GL
SFC WATER	COTTAGE SELF-HELP PROGRAM	Tropic status of inland recreasonal lakes	Chlorophyll, phosphorous	Ontario	> 10yrs	Provincial	MOEE	G. Mysilk	705 690-3241	WATER,WQ
SFC WATER	DILUTION	Dilution calc. for municipal/industrial discharges	co. name, loc, effluent flow,etc	Ontario	4-10 yrs	Provincial	MOEE	A. Bacchus	416 314-7912	CON,EFF,WSDB

APPENDIX 6 (6a)

INVENTORY OF INTERNAL & EXTERNAL ENVIRONMENTAL DATA BASES
ENVIRONMENTAL REPORTING COORDINATION SECTION

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MEDIA CLASS	PROJECT NAME	SUMMARY	PARAMETERS	Geog Coverage	Length of Record	Jurisdiction	Organization	CONTACT NAME	CONTACT PHONE #	KEYWORDS
SFC WATER	EARLY DIAGNOSIS PROJECT	Biological testing to determine tree decline	species, metals, chlorophyll a/b	S. Ont	< 3yrs	Provincial	MOEE	R. Pearson	416 323-5102	AQ, CON, GL
SFC WATER	GREAT LAKES WATER QUALITY DATABAS	Water quality data, phy,chem,biological properties of GL	physical,chemical biological GL	Gr. Lakes	> 10yrs	Federal	EC/CCIW	B. Duffield	416 336-4911	GL,WQ,LAKES
SFC WATER	GREAT LAKES WATER QUALITY	Physical/chemical charact. of Great lakes	physical, organic, nutrients, inorganics	Gr. Lakes	> 10yrs	Provincial	MOEE	P. Dessi	416 314-7866	WQ,CON,GL
SFC WATER	INVENTORY COL. WATERBIRDS NESTING	Results of colonial waterbirds nesting on Canadian GL	loc colony sites,species,# of nests/species,site info	Gr. Lakes	> 10 yrs	Federal	EC/CWS	H. Blokpoel	613 952-2410	BIO,BRDS,GL,WL
SFC WATER	IN-PLACE POLLUTANTS	Concentrations in sediment	metals, nutrients, organics	Ontario	> 10yrs	Provincial	MOEE	R. Jaagumagy	416 314-7922	CON,POLL, WSD
SFC WATER	LAKE INVENTORY	Biological, chemical & physical lake data	fish, chemistry, limnology, habitat, type	Ontario	> 10yrs	Provincial	MNR	G. Gale	416 314-1320	WQ,HYD, LAKES
SFC WATER	LARGE RIVER INVENTORY	Biological,chemical & physical data on large rivers	river, fish species/habitat,etc	Ontario	4-10 yrs	Provincial	MNR	J. Imhoff	905 832-7173	BIO,ECO,RIV
SFC WATER	LONG RANGE TRANSPORT-(BIOLOGICAL)	Inver,plankton abundance/diversity due dep. airborne poll.	acid rain, deposition airborne poll.	Ontario	n/a	Provincial	MOEE	K. Nicholls	416 235-5810	BOT,POLL,GL,
SFC WATER	LONG RANGE TRANSPORT-(CHEMICAL)	Effects of acids, nutrients,contaminants on lakes/streams	nutrients,contaminants,acids,chemistry	Ontario	> 10yrs	Provincial	MOEE	P. Dillon	705 766-2418	SED,WATER,CON
SFC WATER	LOWFLOW	information for low flow periods	station, flow, duration, drainage	Ontario	< 3yrs	Provincial	MOEE	L. Logan	416 235-6227	HYD,WATER, GL
SFC WATER	MOEE MASTER BEACH LIST	Beach location,characteristics and history	name, loc, days posted	Ontario	4-10 yrs	Provincial	MOEE	J. Antoszek	416 314-3891	CZN,HE, REC
SFC WATER	NORTHWESTERN ONT LAKE SIZE SERIES	Data on water chem and aquatic organisms for lakes N. Ont.	nutrients, ions, alkalinity,phytoplankton,fish,pH	Lakes	> 10 yrs	Federal	DFO.	E. Fee	204 983-5172	LAKES,AECO,CLI
SFC WATER	PROV. WATER QUALITY MONITORING	Surface water quality data for rivers/streams	physical, chemical, nutrients, metals	Ontario	> 10yrs	Provincial	MOEE	B. Whitehead	416 235-6256	HYD,WQ,WSDB
SFC WATER	SPRING PHOSPHOROUS	Lakeshore development capacity	phosphorous concentration	Ontario	n/a	Provincial	MOEE	G. Myatik	705 690-3241	PHOS.WATER
SFC WATER	STREAM INVENTORY DATA	Biological,chemical and physical stream data	stream, fish species, chemistry,etc	Ontario	> 10yrs	Provincial	MNR	G. Gale	416 314-1320	HYD, FSH, RIV
SFC WATER	SUDBURY EXTENSIVE LAKES	Relationship between sulfur emmissions & water quality	pH, alkanity, metals	Sudbury	> 10yrs	Provincial	MOEE	W. Keller	705 670-3240	EMS,WQ,
SFC WATER	SUDBURY INTENSIVE LAKES	Adequacy of controls re: aquatic protection & restoration	pH,alkanity,metals zooplankton,phyto	Sudbury	> 10yrs	Provincial	MOEE	W. Keller	705 670-3240	EMS,BIOLOGIGA
SFC WATER	SURFACE WATER TEMP. OF GREAT LAKE	Dbase for surface water temp for the Great Lakes	sfc temp, date, location	Gr. Lakes	> 10 yrs	Federal	EC/AES	P. Louie	416 739-4351	GIS,GL,RMS
SFC WATER	TIDES/WATER LEVEL NETWORK	Water level and flow regulation for Gr. Lakes	water levels	Gr. Lakes		Federal	EC/MSB	L. Kemp	519 823-4201	GL, REC,
SFC WATER	WATER QUANTITY NETWORK	Water quality and discharge data	water level, stream(velocity,discharge)	Ontario	> 10 yrs	Federal	EC/MSB	L. Kemp	519 823-4201	WQ,FSH,HAB
SFC WATER	WATER QUANTITY SURVEYS	Monitor streamflow for water management/env. assessment.	pollution control,environmental contaminants	Ontario	> 10yrs	Provincial	MOEE	Logan/Whitehea	416	CON, WATER
TRANS	HIGHWAY INFORMATION SYSTEM	Highway attributes, usage, deficiencies,etc	location, type, attributes, traffic,etc	Ontario	> 10yrs	Provincial	MOT	M. Perera	416 235-4109	ROADS,TRANS,G
TRANS	MINERAL AGGREGATE INVENTORY	Management of sand,gravel & crushed stone	quarry name, material used	Ontario	> 10yrs	Provincial	MOT	W. Afful	416 235-3733	MRLS,MNG,GL
TRANS	MINERAL DEPOSIT INVENTORY	Skeletal info. regarding mineral deposits	names, location, size, map ref.	N. Ont	n/a	Provincial	MNDM	G. Martino	705 670-5750	MRLS,MNG,GL
TRANS	MOTOR CARRIER,GOODS SURVEY	Survey on motor carriers/Freight & household Good movers	ownership,carrier,revenue,expenses,income accoun	Ontario	> 10 yrs	Federal	SC	Y. Sheikh	613 951-2518	MV,TRANS
TRANS	PROV. SALT AND SAND USE	Inventory of salt/sand use in winter road maint.	salt used per highway, district, sand use	Ontario	> 10yrs	Provincial	MOT	K. Kirshner	416 235-3764	CO,ROADS,GL
TRANS	ROAD MOTOR VEHICLE SURVEY(FUEL)	Monthly summary of fuel sales from pro & Terr fuel sales tax	sales of gas,oil,petroleum,diesel,other fuels	Ontario	> 10 yrs	Federal	SC	Y. Sheikh	613 951-2518	MV,TRANS,FUEL
TRANS	ROAD MOTOR VEHICLES(REGISTRATION)	Statistics on road motor vehicle reg,drivers licence, permits	vehicle reg. type,licences, dealers permits,transfers	Ontario	> 10 yrs	Federal	SC	Y. Sheikh	613 951-2518	TRANS,MV
TRANS	TRAFFIC VOLUME INFORMATION	Traffic volume data for highway sections	highway, volume(annual,seasonal,daily)	Ontario	> 10yrs	Provincial	MOT	P. Saunders	416 235-4115	ROADS,TRANS,G
WASTE	WASTES DISPOSAL SITE INVEN.	Data for active/closed waste disposal sites	site(name,loc.), waste types,etc	Ontario	> 10yrs	Provincial	MOEE	D. Conrod	416 323-5186	CON,WSTE, GL
WASTE	MANIFEST/GENERATOR REGIST.	Information on hazardous/liquid ind. waste transfer	Co.(name,loc), waste(type,volume)	Ontario	4-10yrs	Provincial	MOEE	W. Tse	416 314-7994	TRANS,WSTE,GL
WATER	BULLETIN PH	Statistics of precipitation	amount, pH, path of precip	Ontario	4-10 yrs	Federal	EC/AES	G.Morneau	514 283-1108	AP
WATER	ENVIRONMENT EFFECTS MONITORING	Monitoring for the pulp and paper sector		Ontario		Federal	EC/EHD	J. Merriman		FSH, HAB,
WATER	EXP. LAKES AREA ECOSYSTEM DBASE	Dbase about pristine lakes, streams, watersheds area	water,silica,pH,phytoplankton,fish species,ice data	Lakes	> 10 yrs	Federal	DFO	S. Kasian	204 983-5221	LAKES,AECO,CLI
WATER	GREAT LAKESL HYDRO & HYDRAULIC DA	Historical data on lake levels,outflows,wter supplies..	water levels,lake &riv flows, precip, water diversion	GL_ST.L	> 10yrs	Federal	EC/GL-SLSO	P. Yee	613 936-5725	GL,HYD,ICE,RIV
WATER	GREAT LAKES SEDIMENT DATA	Data physical,chemical for bottom sediment collected GL	physical,chemical prop,metal,organics	GR. Lakes	> 10yrs	Federal	EC/LRB	N. Rukavina	416 336-4880	GL,SED,WQ
WATER	HYDROMETRIC DATA FILE	Data on daily monitoring streamflows,lake levels,sediments.	streamflow,ws level,temp,sed,ice conditions	Ontario	> 10yrs	Federal	EC/WSC	D. Kirk	819 953-1564	HYD,SED,WQ

APPENDIX 6 of

INVENTORY OF INTERNAL & EXTERNAL ENVIRONMENTAL DATA BASES
ENVIRONMENTAL REPORTING COORDINATION SECTION

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MEDIA CLASS	PROJECT NAME	SUMMARY	PARAMETERS	Geographic Area	Length of Record	Jurisdiction	Organization	CONTACT NAME	CONTACT PHONE #	KEYWORDS
WATER	INDEX STORM RAINFALLS IN CANADA	Maps,graphs, depicting synoptic con,time dis of rainfall	storm centre,date,depth,duration,area covered	Ontario	> 10yrs	Federal	EC/CAB	W. Hogg	416 739-4348	PRE,FLDS,STRMS
WATER	INDUSTRIAL WATER USE SURVEYS	Water use by industry thru water intake,discharge,use,cost	water intake,source,treatment,discharge,cost,use	Ontario	> 10yrs	Federal	EC/ECB	D. Tate	819 953-3478	EFF,WSTS,POLL
WATER	INNER LONG PT. BAY	Assess contaminants in Long Pt Bay area	water quality, organics, pesticides	Long Pt		Federal	EC/EHD	J.Merriman		WQ,CO,PEST
WATER	MUN WATERWORKS & WASTEWATER SYS	Data on drinking water treatment & wastewater treatment	mun,pop,flow,water supply & treatment,waste dis	Ontario	> 10yrs	Federal	EC/EP	R. Christensen	819 953-1113	EFF,WSTS,DRW
WATER	MUNICIPAL WATER USE SURVEY	Data on water intake,use,treatment from municipal pop	pumpage,pop,waste treatment,water source	Ontario	>10 yrs	Federal	EC/ECB	D. Lacelle	819 953-1519	EFF,WSTS,GRW
WATER	NATIONAL WATER QUALITY DATABASE	Results of field & Lab. analyses of water quality acjross CA	Aquatic, sed,bact,chemicls &physical properties,pH	Ontario	> 10 yrs	Federal	EC/ESE	P. Brodaisbank	819 997-3434	ENVM,PEST,SED
WATER	PESTICIDES IN NIAGARA RIVER	Analyse upstream/downstream Niagara river		Niagara R		Federal	EC/EHD	D. Williams		PEST,AGR,GL
WATER	PROJECT QUINTE	Effects of Phosphorus removal at sewage treatment plants	water quality, physical, biomass, species	B.Quinte	> 10 yrs	Federal	DFO	S. Millard	416 336-4702	ECOSY,BIO, GL
WATER	RAINY RIVER STUDY	Monitor status of Rainy River	organics	Ontario		Federal	EC/EHD	J.Merriman		RIV, CON
WATER	SEDIMENT QUANTITY NETWORK	Sediment loadings for major tributaries to Great Lakes	sediment level, dissolved solids, part size	Ontario		Federal	EC/MSB	L. Kemp	519 823-4201	AGR,WSDS, GL
WATER	ST CLAIR RIVER WATER QUALITY	Monitor inlet/outlet of St Clair River	nutrients, major ions, metals, etc	St Clair R		Federal	EC/EHD	C. Chan		WQ,CON, HERB
WATER	ST LAWRENCE R. WATER QUALITY	Characterize water quality of ST Lawrence River.	metals, organics, nutrients, ions	St. Lawr		Federal	EC/EHD	G.Bruce		WATER,SED
WATER	TIDES AND WATER LEVELS	In-situ water level gauges,tidal prediction GI, oceans	water elevation,tidal constituents	Gr. Lakes	> 10 yrs	Federal	DFO	J. Gagnon	613 9900260	TIDES,WA
WATER	TRENT SEVERN WATERWAY	Characterize sediment quality along Trent Severn	metals,organics	Tr/Severn		Federal	EC/EHD	R.McCrea		SED, CON
-	AIR PHOTO LIBRARY	Repository for air photo	date,flight line,scale, topo map	Ontario	> 10 yrs	Provincial	MNR	K. Robinson	416 314-1365	RMS, GL
-	CENSUS POPULATION	Information on the social & economic chac of Canadians	ethno-cul,schooling,income,labour force,households	Ontario	> 10 yrs	Federal	SC	R. Bambrick	613 951-3956	DEMO,POP
-	ESTIMATES OF POP BY MARITAL STATUS	Survey of pop. by marital status,age groups,sex for Canada	pop& death status, immigrants & emigrants status	Ontario	> 10 yrs	Federal	SC	L. Champagne	613 951-2320	POP
-	FLOOD STUDIES DATA	Flood risk mapping,data,hydrotechnical anal,watershed data	elevation of flows, watershed pers,land use & soil cove	Ontario	> 10yrs	Federal	EC/WPMB	M. Shaw	416 336-4957	FLD,WATER,WSDS
-	GENERAL SOCIAL SURVEY - CYCLE4	Survey monitors patterns & trends in work & education	work, educ,science &tech,organizations,satisfaction	Ontario	> 10 yrs	Federal	SC	G. Villeneuve	613 951-4996	WKP,EDUC
-	HOSPITAL MEDICAL RECORDS	Hospitalizations and day surgery episodes	patient #, demographic data	Ontario	>10 yrs	Provincial	MOH	M. Gallitz	416 327-7642	DIS,HHE,GL
-	HOUSEHOLD ENVIRONMENT SURVEY	Statistics on household use of environmentally sig. products	disposable items,household haz. waste,composting	Ontario	> 10 yrs	Federal	SC	S. Michell	613-951-3742	HOUSP,HFAC
-	HOUSEHOLD FAC AND EQUIP. SURVEY	Annual estimates of household incomes, facilities & equipment	dwellings characteristics,facilities variables	Ontario	> 10 yrs	Federal	SC	P. Barclay	613 951-4934	BOATS,FUEL
-	MORTALITY AND MORBIDITY	Causes of motality/morbidity	mortality/morbidity cause	Ontario	4-10 yrs	Provincial	MOH	P. Stuckless	416 327-7749	HE, HHE, GL
-	PROJECTIONS OF POP, HOUSEHOLD,FAMILI	Projections of population,households & families in Canada	pop. by age,sex,births,migrants,deaths,households	Ontario	> 10 yrs	Federal	SC	J. Perreult	613 951-2346	DEM,POP
-	PUBLIC OPINION ON THE ENVIRONMENT	Surveys of public opinion on Env.issues: acid rain,atmosphere.	public op: env. issues, waste mgmt, respondent chara	Ontario	> 10 yrs	Federal	EC/PPS	L. Morgan	819 953-9742	PUBLIC OPINION
-	THERMAL GEN. STATION FUEL CONSUM.	Survey collecting fuel consumption from 475 generating plants	station type,fuel,quantity,total cost,generation	Ontario	> 10 yrs	Federal	SC	D. Madsen	613 951-3540	HC,FUEL

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ORGANIZATION:

Provincial:

- MOEE - Ministry of Environment & Energy
- OMAF - Ontario Ministry of Agriculture & Food
- MOH - Ministry of Health
- MOL - Ministry of Labour
- MNR - Ministry of Natural Resources
- MNDM - Ministry of Northern Development & Mines
- MOT - Ministry of Transportation

Federal:

- AGR. CAN- Agriculture Canada
- CMN - Canadian Museum of Nature
- CWS - Canadian Wildlife Service
- DFO - Dept. of Fisheries & Oceans
- EC/AES - Environment Canada/Atmospheric Env. Service
- EC/BSD - Environment Canada/Biological Sciences Directorate
- EC/CAB - Environment Canada/ Climate Adaptation Branch
- EC/CCB - Environment Canada/Commercial Chemicals Branch
- EC/CCC - Environment Canada/Canadian Climate Centre
- EC/CCIW - Environment Canada/Canada Centre for Inland Waters
- EC/ECB - Environment Canada/Economics and Conservation Branch
- EC/EE - Environment Canada/Environmental Emergencies
- EC/EHD - Environment Canada/Ecosystem Health Division
- EC/EISD - Environment Canada/Environmental Information Systems Division
- EC/EP - Environment Canada/Environmental Protection
- EC/EPCP - Environment Canada/Env.Protection,Conserv, & Protection
- EC/ESE - Environment Canada/Ecosystems Sciences and Evaluation
- EC/GLFAS - Environment Canada/Great Lakes Lab. for Fisheries & Aquatic Sc.
- EC/GL-SLSO - Environment Canada/Great Lakes-St.Lawrence Study Office
- EC/ISB - Environment Canada/Inspection Services Branch
- EC/LRB - Environment Canada/Lakes Research Branch
- EC/MBSD - Environment Canada/Migratory Bird Surveys Division
- EC/MMMPD - Environment Canada/Mng,Mineral & Metallurgical Process Div
- EC/MSB - Environment Canada/Monitoring & System Branch
- EC/NRB - Environment Canada/Natural Resources Branch
- EC/NSD - Environment Canada/New Substance Division
- EC/NWRC - Environment Canada/National Wildlife Research Centre
- EC/PCEB - Environment Canada/Program Coordination & Economic Branch
- EC/POAD - Environment Canada/Pollution Data Analysis Division
- EC/PPB - Environment Canada/Policy & Planning Branch
- EC/RRB - Environment Canada/River Research Branch,Conserv. & Prot
- EC/SEB - Environment Canada/Socio-Economic Branch
- EC/WMB - Environment Canada/Waste Management Branch
- EC/WPMB - Environment Canada/Water Planning & Management Branch
- EC/WSC - Environment Canada/Water Survey of Canada
- HWC - Health and Welfare Canada
- ROM - Royal Ontario Museum
- SC - Statistics Canada
- TC - Transport Canada

KEYWORDS:

- AECO - Aquatic ecosys
- AGR - Agriculture
- AP - Acid precipitation
- APOL - Air pollution
- AQ - Air quality
- ATMI - Atmospheric
- BIO - Biota
- BLKDCK- Black duck
- BOT - Botany
- BRDS - Birds
- CA - Cancer
- CHEM - Chemicals
- CFC - Chlorofluorocarbons
- CLI - Climate
- CON - Contaminants
- CZN - coastal Zone
- DEMO - Demography
- ECO - Ecology
- ECOSY- Ecosystem
- EDUC - Education
- EFF - Effluent
- EMI - Emission
- ENDSP- Endangered Species
- ENVM -Environment Mont
- ENVSC- Env. Science
- ERO - Erosion
- ESA - Env. Sensitive Area
- EXT - Extraction
- FF - Ferrous Foundries
- FLD - Flood
- FOR - Forestry
- FSH - Fish
- GEO - Geographical
- GESE- Geese
- GIS - Geo. Info. Ser.
- GL - Great Lakes
- GR W -Groundwater
- HAB - Habitat
- HC - Hydrocarbons
- HCFC - Hydrochlorofluorocar.
- HE - Health
- HERB- Herbicides
- HFAC - Household Ins
- HHE - Human Health
- HOSP - Hospital
- HUM - Humidity
- HYD - Hydrology
- IND - Industry
- INVER - Invertebrates
- MANU - Manufacturing
- MARS - Marsh
- MBRDS- Migratory Birds
- MGR - Migration
- MNG - Mining
- MRLS - Minerals
- MV - Motor Vehicles
- WSTS - Waste
- NPK - National Parks
- PCB - Polychlorinated Biphenyl
- PDY - Pedology
- PEST- Pesticides
- POLL - Pollution
- POP - Population
- PREC- Precipitation
- RADN - Radiation
- REC - Recreation
- REPT- Reptile
- RESO- Residue
- RIV - River
- RMS -Remote Sensing
- SED - Sediment
- SPC - Species
- STRMS - Storms
- SUDBY- Sudbury
- TECH - Technology
- TEMP -Temperature
- TISS- Tissue
- TOUR - Tourism
- TRANS- Transportation
- TXCHEM- Toxic Chemicals
- WDL - Wildlife
- WDLNDS-Woodlands
- WKP - Workplace
- WQ - Qater quality
- WSDS - Watersheds

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